



US Army Corps  
of Engineers  
Tulsa District

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Fort Sill, Oklahoma

# **Whole Barracks Complex Renewal**

## **Project Specifications Volume I of V**

October 1998

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## INFORMATION

For information regarding site conditions and the equipment ownership and operating expense schedule contact Rick West, Resident Engineer at Ft. Sill Resident Office, Corps of Engineers, PO Box 33159, Ft. Sill, OK 73503-0159, tel: 580-355-6148.

For technical information regarding plans and specifications contact Mr. Randall Lewis, Tulsa District Office, Corps of Engineers, Tulsa, Oklahoma, telephone AC 918-669-7034.

For information regarding bidding procedures, bonds, additional sets of plans and specifications, and lists of plans holders contact Contracting Division, telephone AC 918-669-7275, Tulsa, Oklahoma.

Collect calls not accepted.

SRW

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## SECTION 00010

<b>SOLICITATION, OFFER AND AWARD</b> (Construction, Alteration, or Repair)	1. SOLICITATION NO.  DACA56-99-B-0002	2. TYPE OF SOLICITATION <input checked="" type="checkbox"/> SEALED BID (IFB) <input type="checkbox"/> NEGOTIATED (RFP)	3. DATE ISSUED  23 October 1998	PAGE OF PAGES  1 of 4

**IMPORTANT** - The "offer" section on the reverse must be fully completed by the offeror.

4. CONTRACT NO.		5. REQUISITION/PURCHASE REQUEST NO.		6. PROJECT NO.
7. ISSUED BY  Department of the Army Corps of Engineers Tulsa District		W44XGQ	8. ADDRESS OFFER TO  The Contracting Officer Tulsa District, Corps of Engineers ATTN: Contracting Division PO Box 61 (1645 South 101st East Avenue) Tulsa, OK 74121-0061	
9. FOR INFORMATION CALL:	A. NAME  See preceding page		B. TELEPHONE NO. (Include area code) (NO COLLECT CALLS)	

**SOLICITATION**

NOTE: In sealed bid solicitations "offer" and "offeror" mean "bid" and "bidder".

10. THE GOVERNMENT REQUIRES PERFORMANCE OF THE WORK DESCRIBED IN THESE DOCUMENTS (Title, identifying no., date):

Whole Barracks Complex Renewal  
Fort Sill, Oklahoma

**Approximate Value: \$25,000,000 to \$100,000,000**

**DIRECTIONS FOR SUBMITTING BIDS:**

ENVELOPES CONTAINING BIDS, GUARANTEE, ETC., MUST BE SEALED, MARKED, AND ADDRESSED AS FOLLOWS:

MARK ENVELOPE "BID UNDER SOLICITATION NO. DACA56-99-B-0002 TO BE OPENED AT 2:00 P.M. 3 December 1998

RECEIPT OF AMENDMENTS NOS. \_\_\_\_\_ ACKNOWLEDGED"

ADDRESS BIDS TO: SEE BLOCK 8 ABOVE

HAND-CARRIED BIDS: HAND-CARRIED BIDS PRIOR TO 1:30 P.M. MUST BE DEPOSITED IN THE "BID DEPOSITORY" IN ROOM 130, 1645 SOUTH 101st EAST AVENUE, TULSA, OK 74128.  
HAND-CARRIED BIDS AFTER 1:30 P.M. MUST BE DEPOSITED IN THE "BID DEPOSITORY" IN ROOM 210 PRIOR TO THE TIME STATED FOR OPENING OF BIDS. (FAR 14.401)

11. The Contractor shall begin performance within 10 calendar days and complete it within   \* calendar days after receiving ☐ award ☒ notice to proceed. This performance period is ☒ mandatory, ☐ negotiable. (\*See Section 00800 - Special Contract Requirements)

12A. THE CONTRACTOR MUST FURNISH ANY REQUIRED PERFORMANCE AND PAYMENT BONDS (If "YES", indicate within how many calendar days after award in item 12B)  <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	12B. CALENDAR DAYS  10
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**13 ADDITIONAL SOLICITATION REQUIREMENTS:**

A. Sealed offers in original and no copies to perform the work required are due at the place specified in Item 8 by 2:00 p.m. local time

**3 December 1998.** If this is a sealed bid solicitation, offers will be publicly opened at the time. Sealed envelopes containing offers shall be marked to show the offeror's name and address, the solicitation number, and the date and time the offers are due.

B. An offer guarantee is required. **NOTE: Bid guarantee is required with any bid in excess of \$25,000.**

C. All offers are subject to the (1) work requirements, and (2) other provisions and clauses incorporated in the solicitation in full text or by reference.

D. Offers providing less than 60 calendar days for Government acceptance after the date offers are due will not be considered and will be rejected.

## OFFER (Must be fully completed by the offeror)

14. NAME AND ADDRESS OF OFFEROR (Include ZIP Code)		15. TELEPHONE NO. (Include Area Code)
		FAX NO.
		16. REMITTANCE ADDRESS (Include only if different than Item 14)
		CAGE Contractor Established No.
		DUNS Contractor Established No.
CODE	FACILITY CODE	

17. The offeror agrees to perform the work required at the prices specified below in strict accordance with the terms of this solicitation, if this offer is accepted by the Government in writing within \_\_\_\_\_ calendar days after the date offers are due. (Insert any number equal to or greater than the minimum requirement stated in Item 13D. Failure to insert any number means the offeror accepts the minimum in item 13D.)

AMOUNTS

&gt;

Set forth in the attached Bidding Schedule

18. The Offeror agrees to furnish any required performance and payment bonds.

## 19. ACKNOWLEDGEMENT OF AMENDMENTS

(The Offeror acknowledges receipt of amendments to the solicitation -- give number and date of each)

AMENDMENT NO.								
DATE								

20A. NAME AND TITLE OF PERSON AUTHORIZED TO SIGN OFFER (Type or Print)	20B. SIGNATURE	20C. OFFER DATE

## AWARD (To be completed by Government)

21. ITEMS ACCEPTED:

22. AMOUNT	23. ACCOUNTING AND APPROPRIATION DATA	
24. SUBMIT INVOICES TO ADDRESS SHOWN IN (4 copies unless otherwise specified)	ITEM	25. OTHER THAN FULL AND OPEN COMPETITION PURSUANT TO <input type="checkbox"/> 10 U.S.C. 2304(c)( ) <input type="checkbox"/> 41 U.S.C. 253(c)( )
26. ADMINISTERED BY	CODE	27. PAYMENT WILL BE MADE BY

## CONTRACTING OFFICER WILL COMPLETE ITEM 28 OR 29 AS APPLICABLE

<input type="checkbox"/> 28. NEGOTIATED AGREEMENT (Contractor is required to sign this document and return _____ copies to issuing Office.) Contractor agrees to furnish and deliver all items or perform all work requirements identified on this form and any continuation sheets for the consideration stated in this contract. The rights and obligations of the parties to this contract shall be governed by (a) this contract award, (b) the solicitation, and (c) the clauses, representations, certifications, and specifications incorporated by reference in or attached to this contract.		<input type="checkbox"/> 29. AWARD ( Contractor is not required to sign this document.) Your offer on this solicitation is hereby accepted as to the items listed. This award consummates the contract, which consist of (a) the Government solicitation and your offer, and (b) this contract award. No further contractual document is necessary.	
30A. NAME AND TITLE OF CONTRACTOR OR PERSON AUTHORIZED TO SIGN (Type or Print)		31A. NAME OF CONTRACTING OFFICER (Type or Print)	
30B. SIGNATURE	30C. DATE	31B. UNITED STATES OF AMERICA BY	31C. AWARD DATE



## BIDDING SCHEDULE

Item No.	Description	Quantity	Unit	Unit Price	Amount
1.	Two Barracks (nos. 2 and 3), modifications as shown to Community Building 1, parking/ landscaped areas and other work as shown on the Drawings	Sum	Job	xxxx	_____
2.	Four Barracks (nos. 4, 5, 6, 7), Community Building 2, parking/ landscaped areas and other work as shown on the Drawings	Sum	Job	xxxx	_____
3.	Performance Award Fee (See note below)	Sum	Job	xxxx	<b>250,000</b>
4.	Drilled piers:				
(a)	457mm diameter	4,535	LM	\$_____	_____
(b)	610mm diameter	664	LM	\$_____	_____
(c)	762mm diameter	414	LM	\$_____	_____
(d)	914mm diameter	551	LM	\$_____	_____
TOTAL BASE BID (items 1 through 4)					_____

## OPTIONS

5.	OPTION No. 1				
	Two Barracks (nos. 8 and 9) and other work as shown on the Drawings	Sum	Job	xxxx	_____
	Drilled piers:				
(a)	457mm diameter	1,115	LM	\$_____	_____
(b)	610mm diameter	245	LM	\$_____	_____
(c)	762mm diameter	218	LM	\$_____	_____
(d)	914mm diameter	290	LM	\$_____	_____

6.	OPTION No. 2	Sum	Job	xxxx	_____
	One Barracks (no. 10), parking/landscaped areas and other work as shown on the Drawings				
	Drilled piers:				
(a)	457mm diameter	512	LM	\$_____	_____
(b)	610mm diameter	113	LM	\$_____	_____
(c)	762mm diameter	100	LM	\$_____	_____
(d)	914mm diameter	133	LM	\$_____	_____
	TOTAL OPTIONAL BID ITEMS (Items 5a-d and 6a-d)				
	_____				

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TOTAL BASE BID AND OPTIONS \_\_\_\_\_

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#### BIDDING SCHEDULE NOTES

1. Bidders shall bid on all items.
2. Only one contract for the entire schedule will be awarded under this solicitation.
3. Optional bid items shall be as shown on the drawings.  
  
Optional bid items may, at the option of the Government, be added to the contract at any time within 90 days after Notice to Proceed is issued. The government will evaluate offers for award purposes by adding the total price for options to the total price for the Base Bid (TOTAL BASE BID AND OPTIONS). Evaluation of options will not obligate the government to exercise the options.  
  
Options shall be evaluated in accordance with the clause EVALUATION OF OPTIONS in Section 00100.
4. The Performance Award Fee is an amount which may be earned by the Contractor based on performance evaluation during construction. See Section 01200.

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## SECTION 00100

### INSTRUCTIONS, CONDITIONS, AND NOTICES TO BIDDERS

#### 1 52.252-1 SOLICITATION PROVISIONS INCORPORATED BY REFERENCE (FEB 1998)

This solicitation incorporates one or more solicitation provisions by reference, with the same force and effect as if they were given in full text. Upon request, the Contracting Officer will make their full text available. The offeror is cautioned that the listed provisions may include blocks that must be completed by the offeror and submitted with its quotation or offer. In lieu of submitting the full text of those provisions, the offeror may identify the provision by paragraph identifier and provide the appropriate information with its quotation or offer. Also, the full text of a solicitation provision may be accessed electronically at these addresses:

<http://www.arnet.gov/far>

<http://farsite.hill.af.mil>

<http://www.dtic.mil/dfars>

(End of provision)

#### 2 52.204-6 DATA UNIVERSAL NUMBERING SYSTEM (DUNS) NUMBER (APR 1998)

(a) The offeror shall enter, in the block with its name and address on the cover page of its offer, the annotation "DUNS" followed by the DUNS number which identifies the offeror's name and address exactly as stated in the offer. The DUNS number is a nine-digit number assigned by Dun and Bradstreet Information Services.

(b) If the offeror does not have a DUNS number, it should contact Dun and Bradstreet directly to obtain one. A DUNS number will be provided immediately by telephone at no charge to the offeror. For information on obtaining a DUNS number, the offeror, if located within the United States, should call Dun and Bradstreet at 1-800-333-0505. The offeror should be prepared to provide the following information:

- (1) Company name.
- (2) Company address.
- (3) Company telephone number.
- (4) Line of business.
- (5) Chief executive officer/key manager.
- (6) Date the company was started.
- (7) Number of people employed by the company.
- (8) Company affiliation.

(c) Offerors located outside the United States may obtain the location and phone number of the local Dun and Bradstreet Information Services office from the Internet home page at <http://www.dnb.com/>. If an offeror is unable to locate a local service center, it may send an e-mail to Dun and Bradstreet at [globalinfo@mail.dnb.com](mailto:globalinfo@mail.dnb.com).

(End of provision)

3 52.211-14 NOTICE OF PRIORITY RATING FOR NATIONAL DEFENSE USE (SEP 1990)

Any contract awarded as a result of this solicitation will be /\_\_\_\_\_ / DX rated order; /X/ D0 rated order certified for national defense use under the Defense Priorities and Allocations System (DPAS) (15 CFR 700), and the Contractor will be required to follow all of the requirements of this regulation.

(End of provision)

4 52.214-1 SOLICITATION DEFINITIONS--SEALED BIDDING (JUL 1987)

"Government" means United States Government.

"Offer" means "bid" in sealed bidding.

"Solicitation" means an invitation for bids in sealed bidding.

(End of provision)

5 52.214-3 AMENDMENTS TO INVITATIONS FOR BIDS (DEC 1989)

(a) If this solicitation is amended, then all terms and conditions which are not modified remain unchanged.

(b) Bidders shall acknowledge receipt of any amendment to this solicitation (1) by signing and returning the amendment, (2) by identifying the amendment number and date in the space provided for this purpose on the form for submitting a bid, (3) by letter or telegram, or (4) by facsimile, if facsimile bids are authorized in the solicitation. The Government must receive the acknowledgment by the time and at the place specified for receipt of bids.

(End of provision)

6 52.214-4 FALSE STATEMENTS IN BIDS (APR 1984)

Bidders must provide full, accurate, and complete information as required by this solicitation and its attachments. The penalty for making false statements in bids is prescribed in 18 U.S.C. 1001.

(End of provision)

(R 2-201(b)(xiii))

(R 1-2.201(a)(11))

7 52.214-5 SUBMISSION OF BIDS (MAR 1997)

(a) Bids and bid modifications shall be submitted in sealed envelopes or packages (unless submitted by electronic means) (1) addressed to the office specified in the solicitation, and (2) showing the time and date specified for receipt, the solicitation number, and the name and address of the bidder.

(b) Bidders using commercial carrier services shall ensure that the bid is addressed and marked on the outermost envelope or wrapper as prescribed in subparagraphs (a) (1) and (2) of this provision when delivered to the office specified in the solicitation.

(c) Telegraphic bids will not be considered unless authorized by the solicitation; however, bids may be modified or withdrawn by written or telegraphic notice.

(d) Facsimile bids, modifications, or withdrawals, will not be considered unless authorized by the solicitation.

(e) Bids submitted by electronic commerce shall be considered only if the electronic commerce method was specifically stipulated or permitted by the solicitation.

(End of provision)

8 52.214-6 EXPLANATION TO PROSPECTIVE BIDDERS (APR 1984)

Any prospective bidder desiring an explanation or interpretation of the solicitation, drawings, specifications, etc., must request it in writing soon enough to allow a reply to reach all prospective bidders before the submission of their bids. Oral explanations or instructions given before the award of a contract will not be binding. Any information given a prospective bidder concerning a solicitation will be furnished promptly to all other prospective bidders as an amendment to the solicitation, if that information is necessary in submitting bids or if the lack of it would be prejudicial to other prospective bidders.

(End of provision)

(R SF 33A, Para 3, 1978 JAN)

9 52.214-7 LATE SUBMISSIONS, MODIFICATIONS, AND WITHDRAWALS OF BIDS (MAY 1997)

(a) Any bid received at the office designated in the solicitation after the exact time specified for receipt will not be considered unless it is received before award is made and it--

(1) Was sent by registered or certified mail not later than the fifth calendar day before the date specified for receipt of bids (e.g., a bid submitted in response to a solicitation requiring receipt of bids by the 20th of the month must have been mailed by the 15th);

(2) Was sent by mail (or telegram or facsimile, if authorized) or hand-carried (including delivery by a commercial carrier) if it is determined by the Government that the late receipt was due primarily to Government mishandling after receipt at the Government installation;

(3) Was sent by U.S. Postal Service Express Mail Next Day Service-Post Office To Addressee, not later than 5:00 P.M. at the place of mailing two working days prior to the date specified for receipt of bids. The term "working days" excludes weekends and U.S. Federal holidays; or

(4) Was transmitted through an electronic commerce method authorized by the solicitation and was received at the initial point of entry to the Government infrastructure not later than 5:00 p.m. one working day prior to the date specified for receipt of bids.

(b) Any modification or withdrawal of a bid is subject to the same conditions as in paragraph (a) of this provision.

(c) The only acceptable evidence to establish the date of mailing of a late bid, modification, or withdrawal sent either by registered or certified mail is the U.S. or Canadian Postal Service postmark both on the envelope or wrapper and on the original receipt from the U.S. or Canadian Postal Service. Both postmarks must show a legible date or the bid, modification, or withdrawal shall be processed as if mailed late. "Postmark" means a printed, stamped, or otherwise placed impression (exclusive of a postage meter machine impression) that is readily identifiable without further action as having been supplied and affixed by employees of the U.S. or Canadian Postal Service on the date of mailing. Therefore, bidders should request the postal clerk to place a legible hand cancellation bull's-eye postmark on both the receipt and the envelope or wrapper.

(d) The only acceptable evidence to establish the time of receipt at the Government installation is the time/date stamp of that installation on the bid wrapper or other documentary evidence of receipt maintained by the installation.

(e) The only acceptable evidence to establish the date of mailing of a late bid, modification, or withdrawal sent by U.S. Postal Service Express Mail Next Day Service-Post Office to Addressee is the date entered by the post office receiving clerk on the "Express Mail Next Day Service-Post Office to Addressee" label and the postmark on the envelope or wrapper and on the original receipt from the U.S. Postal Service. "Postmark" has the same meaning as defined in paragraph (c) of this provision, excluding postmarks of the Canadian Postal Service. Therefore, bidders should request the postal clerk to place a legible hand cancellation bull's-eye postmark on both the receipt and the envelope or wrapper.

(f) Notwithstanding paragraph (a) of this provision, a late modification of an otherwise successful bid that makes its terms more favorable to the Government will be considered at any time it is received and may be accepted.

(g) Bids may be withdrawn by written notice or telegram (including

mailgram) received at any time before the exact time set for receipt of bids. If the solicitation authorizes facsimile bids, bids may be withdrawn via facsimile received at any time before the exact time set for receipt of bids, subject to the conditions specified in the provision entitled "Facsimile Bids." A bid may be withdrawn in person by a bidder or its authorized representative if, before the exact time set for receipt of bids, the identity of the person requesting withdrawal is established and the person signs a receipt for the bid.

(h) If an emergency or unanticipated event interrupts normal Government processes so as to cause postponement of the scheduled bid opening, and urgent Government requirements preclude amendment of the solicitation or other notice of an extension of the opening date, the time specified for receipt of bids will be deemed to be extended to the same time of day specified in the solicitation on the first work day on which normal Government processes resume.

(End of provision)

10 52.214-18 PREPARATION OF BIDS--CONSTRUCTION (APR 1984)

(a) Bids must be (1) submitted on the forms furnished by the Government or on copies of those forms, and (2) manually signed. The person signing a bid must initial each erasure or change appearing on any bid form.

(b) The bid form may require bidders to submit bid prices for one or more items on various bases, including--

- (1) Lump sum bidding;
- (2) Alternate prices;
- (3) Units of construction; or
- (4) Any combination of subparagraphs (1) through (3) above.

(c) If the solicitation requires bidding on all items, failure to do so will disqualify the bid. If bidding on all items is not required, bidders should insert the words "no bid" in the space provided for any item on which no price is submitted.

(d) Alternate bids will not be considered unless this solicitation authorizes their submission.

(End of provision)

(R SF 22, Para 5, 1978 FEB)

11 52.214-19 CONTRACT AWARD--SEALED BIDDING--CONSTRUCTION (AUG 1996)

(a) The Government will evaluate bids in response to this solicitation without discussions and will award a contract to the responsible bidder whose bid, conforming to the solicitation, will be most advantageous to the Government, considering only price and the price-related factors specified elsewhere in the solicitation.



(b) The Government may reject any or all bids, and waive informalities or minor irregularities in bids received.

(c) The Government may accept any item or combination of items, unless doing so is precluded by a restrictive limitation in the solicitation or the bid.

(d) The Government may reject a bid as nonresponsive if the prices bid are materially unbalanced between line items or subline items. A bid is materially unbalanced when it is based on prices significantly less than cost for some work and prices which are significantly overstated in relation to cost for other work, and if there is a reasonable doubt that the bid will result in the lowest overall cost to the Government even though it may be the low evaluated bid, or if it is so unbalanced as to be tantamount to allowing an advance payment.

(End of provision)

12 52.215-13 SUBCONTRACTOR COST OR PRICING DATA--MODIFICATIONS (OCT 1997)

(a) The requirements of paragraphs (b) and (c) of this clause shall--

(1) Become operative only for any modification to this contract involving a pricing adjustment expected to exceed the threshold for submission of cost or pricing data at FAR 15.403-4; and

(2) Be limited to such modifications.

(b) Before awarding any subcontract expected to exceed the threshold for submission of cost or pricing data at FAR 15.403-4, on the date of agreement on price or the date of award, whichever is later; or before pricing any subcontract modification involving a pricing adjustment expected to exceed the threshold for submission of cost or pricing data at FAR 15.403-4, the Contractor shall require the subcontractor to submit cost or pricing data (actually or by specific identification in writing), unless an exception under FAR 15.403-1 applies.

(c) The Contractor shall require the subcontractor to certify in substantially the form prescribed in FAR 15.406-2 that, to the best of its knowledge and belief, the data submitted under paragraph (b) of this clause were accurate, complete, and current as of the date of agreement on the negotiated price of the subcontract or subcontract modification.

(d) The Contractor shall insert the substance of this clause, including this paragraph (d), in each subcontract that exceeds the threshold for submission of cost or pricing data at FAR 15.403-4 on the date of agreement on price or the date of award, whichever is later.

(End of clause)

13 52.217-5 EVALUATION OF OPTIONS (JUL 1990)

Except when it is determined in accordance with FAR 17.206(b) not to be in the Government's best interests, the Government will evaluate offers

for award purposes by adding the total price for all options to the total price for the basic requirement. Evaluation of options will not obligate the Government to exercise the option(s).

(End of provision)

14 52.222-23 D NOTICE OF REQUIREMENT FOR AFFIRMATIVE ACTION TO ENSURE EQUAL EMPLOYMENT  
OPPORTUNITY FOR CONSTRUCTION (APR 1984) (DEVIATION)

(a) The offeror's attention is called to the Equal Opportunity clause and the Affirmative Action Compliance Requirements for Construction clause of this solicitation.

(b) The goals for minority and female participation, expressed in percentage terms for the Contractor's aggregate workforce in each trade on all construction work in the covered area, are as follows:

Goals for minority participation for each trade	Goals for female participation for each trade
14.8%	6.9%

These goals are applicable to all the Contractor's construction work performed in the covered area. If the Contractor performs construction work in a geographical area located outside of the covered area, the Contractor shall apply the goals established for the geographical area where the work is actually performed. Goals are published periodically in the Federal Register in notice form, and these notices may be obtained from any Office of Federal Contract Compliance Programs office.

(c) The Contractor's compliance with Executive Order 11246, as amended, and the regulations in 41 CFR 60-4 shall be based on (1) its implementation of the Equal Opportunity clause, (2) specific affirmative action obligations required by the clause entitled "Affirmative Action Compliance Requirements for Construction," and (3) its efforts to meet the goals. The hours of minority and female employment and training must be substantially uniform throughout the length of the contract, and in each trade. The Contractor shall make a good faith effort to employ minorities and women evenly on each of its projects. The transfer of minority or female employees or trainees from Contractor to Contractor, or from project to project, for the sole purpose of meeting the Contractor's goals shall be a violation of the contract, Executive Order 11246, as amended, and the regulations in 41 CFR 60-4. Compliance with the goals will be measured against the total work hours performed.

(d) The Contractor shall provide written notification to the Deputy Assistant Secretary for Federal Contract Compliance Programs, within 10 working days following award of any construction subcontract in excess of \$10,000 at any tier for construction work under the contract resulting from this solicitation. The notification shall list the--

- (1) Name, address, and telephone number of the subcontractor;
- (2) Employer's identification number of the subcontractor;
- (3) Estimated dollar amount of the subcontract;
- (4) Estimated starting and completion dates of the subcontract; and
- (5) Geographical area in which the subcontract is to be performed.

(e) As used in this Notice, and in any contract resulting from this solicitation, the "covered area" is Oklahoma/Comanche County/Lawton.

(End of provision)

15    52.225-13 I    NOTICE OF BUY AMERICAN ACT REQUIREMENT--CONSTRUCTION MATERIALS UNDER  
TRADE AGREEMENTS ACT AND NORTH AMERICAN FREE TRADE AGREEMENT (MAY 1997)  
--ALTERNATE I (MAY 1997)

(a) Offerors are required to comply with the requirements of Federal Acquisition Regulation (FAR) clause 52.225-15, Buy American Act--Construction Materials Under Trade Agreements Act and North American Free Trade Agreement, of this solicitation. The terms defined in FAR clause 52.225-15 have the same meaning in this provision.

(b) An offeror requesting a determination regarding the inapplicability of the Buy American Act shall submit such request with its offer, including the information and applicable supporting data required by paragraphs (c) and (d) of FAR clause 52.225-15.

(c) Evaluation of offers.

(1) For evaluation of offers, (unless agency regulations specify a higher percentage) the Government will add to the offered price 6 percent of the cost of any foreign construction material proposed for exception from the requirements of the Buy American Act based on claimed unreasonable cost of domestic construction materials in accordance with paragraph (b)(4)(i) of FAR clause 52.225-15.

(2) If the evaluation of offers results in a tie between an offer including such foreign construction material excepted on the basis of unreasonable cost, as evaluated, and an offer including solely domestic construction material or other foreign construction material, listed in the solicitation at paragraph (b)(3) of FAR clause 52.225-15, or subsequently excepted in accordance with paragraphs (b)(4)(ii) or (iii) of FAR clause 52.225-15, award shall be made to the offeror that submitted the latter offer.

(d) Alternate offers.

(1) When an offer includes foreign construction material not listed by the Government in the solicitation at paragraph (b)(3) of FAR clause 52.225-15, offerors also may submit alternate offers based on use of equivalent domestic construction material.

(2) If alternate offers are submitted, a separate Standard Form 1442 shall be submitted for each alternate offer, and a separate price comparison table, prepared in accordance with paragraphs (c) and (d) of

FAR clause 52.225-15, shall be submitted for each offer that is based on the use of any foreign construction material for which the Government has not yet determined an exception to apply.

(3) If the Government determines that a particular exception requested under paragraph (c) of FAR clause 52.225-15 does not apply, the Government will evaluate only those offers based on use of the equivalent domestic construction material, and the offeror shall be required to furnish such domestic construction material.

(i) In sealed bid procurements, any offer based on use of that particular foreign construction material shall be rejected as nonresponsive.

(ii) in negotiated procurements, any offer based on use of that particular foreign construction material may not be accepted unless revised during negotiations.

(End of provision)

16 52.228-1 BID GUARANTEE (SEP 1996)

(a) Failure to furnish a bid guarantee in the proper form and amount, by the time set for opening of bids, may be cause for rejection of the bid.

(b) The bidder shall furnish a bid guarantee in the form of a firm commitment, e.g., bid bond supported by good and sufficient surety or sureties acceptable to the Government, postal money order, certified check, cashier's check, irrevocable letter of credit, or, under Treasury Department regulations, certain bonds or notes of the United States. The Contracting Officer will return bid guarantees, other than bid bonds, (1) to unsuccessful bidders as soon as practicable after the opening of bids, and (2) to the successful bidder upon execution of contractual documents and bonds (including any necessary coinsurance or reinsurance agreements), as required by the bid as accepted.

(c) The amount of the bid guarantee shall be twenty (20) percent of the bid price or \$3,000,000, whichever is less.

(d) If the successful bidder, upon acceptance of its bid by the Government within the period specified for acceptance, fails to execute all contractual documents or furnish executed bond(s) within 10 days after receipt of the forms by the bidder, the Contracting Officer may terminate the contract for default.

(e) In the event the contract is terminated for default, the bidder is liable for any cost of acquiring the work that exceeds the amount of its bid, and the bid guarantee is available to offset the difference.

(End of provision)

(a) "Irrevocable letter of credit" (ILC), as used in this clause, means a written commitment by a federally insured financial institution to pay all or part of a stated amount of money, until the expiration date of the letter, upon presentation by the Government (the beneficiary) of a written demand therefor. Neither the financial institution nor the offeror/Contractor can revoke or condition the letter of credit.

(b) If the offeror intends to use an ILC in lieu of a bid bond, or to secure other types of bonds such as performance and payment bonds, the letter of credit and letter of confirmation formats in paragraphs (e) and (f) of this clause shall be used.

(c) The letter of credit shall be irrevocable, shall require presentation of no document other than a written demand and the ILC (including confirming letter, if any), shall be issued/confirmed by an acceptable federally insured financial institution as provided in paragraph (d) of this clause, and--

(1) If used as a bid guarantee, the ILC shall expire no earlier than 60 days after the close of the bid acceptance period;

(2) If used as an alternative to corporate or individual sureties as security for a performance or payment bond, the offeror/Contractor may submit an ILC with an initial expiration date estimated to cover the entire period for which financial security is required or may submit an ILC with an initial expiration date that is a minimum period of one year from the date of issuance. The ILC shall provide that, unless the issuer provides the beneficiary written notice of non-renewal at least 60 days in advance of the current expiration date, the ILC is automatically extended without amendment for one year from the expiration date, or any future expiration date, until the period of required coverage is completed and the Contracting Officer provides the financial institution with a written statement waiving the right to payment. The period of required coverage shall be:

(i) For contracts subject to the Miller Act, the later of--

(A) One year following the expected date of final payment;

(B) For performance bonds only, until completion of any warranty period; or

(C) For payment bonds only, until resolution of all claims filed against the payment bond during the one-year period following final payment.

(ii) For contracts not subject to the Miller Act, the later of--

(A) 90 days following final payment; or

(B) For performance bonds only, until completion of any warranty period.

(d) Only federally insured financial institutions rated investment grade or higher shall issue or confirm the ILC. The offeror/Contractor shall provide the Contracting Officer a credit rating that indicates the

financial institution has the required rating(s) as of the date of issuance of the ILC. Unless the financial institution issuing the ILC had letter of credit business of at least \$25 million in the past year, ILCs over \$5 million must be confirmed by another acceptable financial institution that had letter of credit business of at least \$25 million in the past year.

(e) The following format shall be used by the issuing financial institution to create an ILC:

(Issuing Financial Institution's Letterhead or Name and Address)

Issue Date \_\_\_\_\_

Irrevocable Letter of Credit No. \_\_\_\_\_

Account party's name \_\_\_\_\_

Account party's address \_\_\_\_\_

For Solicitation No. \_\_\_\_\_

(For reference only)

T0: (U.S. Government agency)

(U.S. Government agency's address)

1. We hereby establish this irrevocable and transferable Letter of Credit in your favor for one or more drawings up to United States \$ \_\_\_\_\_. This Letter of Credit is payable at (issuing financial institution's and, if any, confirming financial institution's) office at (issuing financial institution's address and, if any, confirming financial institution's address) and expires with our close of business on \_\_\_\_\_, or any automatically extended expiration date.

2. We hereby undertake to honor your or the transferee's sight draft(s) drawn on the issuing or, if any, the confirming financial institution, for all or any part of this credit if presented with this Letter of Credit and confirmation, if any, at the office specified in paragraph 1 of this Letter of Credit on or before the expiration date or any automatically extended expiration date.

3. (This paragraph is omitted if used as a bid guarantee, and subsequent paragraphs are renumbered.) It is a condition of this Letter of Credit that it is deemed to be automatically extended without amendment for one year from the expiration date hereof, or any future expiration date, unless at least 60 days prior to any expiration date, we notify you or the transferee by registered mail, or other receipted means of delivery, that we elect not to consider this Letter of Credit renewed for any such additional period. At the time we notify you, we also agree to notify the account party (and confirming financial institution, if any) by the same means of delivery.

4. This Letter of Credit is transferable. Transfers and assignments of proceeds are to be effected without charge to either the beneficiary or the transferee/assignee of proceeds. Such transfer or assignment shall be only at the written direction of the Government (the beneficiary) in a form satisfactory to the issuing financial institution and the confirming financial institution, if any.

5. This Letter of Credit is subject to the Uniform Customs and Practice (UCP) for Documentary Credits, 1993 Revision, International Chamber of Commerce Publication No. 500, and to the extent not inconsistent therewith, to the laws of \_\_\_\_\_ (state of confirming financial institution, if any, otherwise state of issuing financial institution).

6. If this credit expires during an interruption of business of this financial institution as described in Article 17 of the UCP, the financial institution specifically agrees to effect payment if this credit is drawn against within 30 days after the resumption of our business.

Sincerely,

(Issuing financial institution)

(f) The following format shall be used by the financial institution to confirm an ILC:

(Confirming Financial Institution's Letterhead or Name and Address)

Date \_\_\_\_\_ 19\_\_\_\_

Our Letter of Credit Advice Number \_\_\_\_\_

Beneficiary: \_\_\_\_\_

(U.S. Government agency)

Issuing Financial Institution: \_\_\_\_\_

Issuing Financial Institution's LC No.: \_\_\_\_\_

Gentlemen:

1. We hereby confirm the above indicated Letter of Credit, the original of which is attached, issued by \_\_\_\_\_ (name of issuing financial institution) for drawings of up to United States dollars \_\_\_\_\_/U.S. \$\_\_\_\_\_ and expiring with our close of business on \_\_\_\_\_ (the expiration date), or any automatically extended expiration date.

2. Draft(s) drawn under the Letter of Credit and this Confirmation are payable at our office located at \_\_\_\_\_.

3. We hereby undertake to honor sight draft(s) drawn under and presented with the Letter of Credit and this Confirmation at our offices as specified herein.

4. (This paragraph is omitted if used as a bid guarantee, and subsequent paragraphs are renumbered.) It is a condition of this confirmation that it be deemed automatically extended without amendment for one year from the expiration date hereof, or any automatically extended expiration date, unless:

(a) At least 60 days prior to any such expiration date, we shall notify the Contracting Officer, or the transferee and the issuing financial institution, by registered mail or other receipted means of delivery, that we elect not to consider this confirmation extended for any such additional period; or

(b) The issuing financial institution shall have exercised its right to notify you or the transferee, the account party, and ourselves, of its election not to extend the expiration date of the Letter of Credit.

5. This confirmation is subject to the Uniform Customs and Practice (UCP) for Documentary Credits, 1993 Revision, International Chamber of Commerce Publication No. 500, and to the extent not inconsistent therewith, to the laws of \_\_\_\_\_ (state of confirming financial institution).

6. If this confirmation expires during an interruption of business of this financial institution as described in Article 17 of the UCP, we specifically agree to effect payment if this credit is drawn against within 30 days after the resumption of our business.

Sincerely,

(Confirming financial institution)

(g) The following format shall be used by the Contracting Officer for a sight draft to draw on the Letter of Credit:

SIGHT DRAFT

\_\_\_\_\_  
(City, State)

\_\_\_\_\_, 19\_\_\_\_

\_\_\_\_\_  
(Name and address of financial institution)

Pay to the order of \_\_\_\_\_

(Beneficiary Agency)

the sum of United States \$ \_\_\_\_\_

This draft is drawn under \_\_\_\_\_

Irrevocable Letter of Credit No. \_\_\_\_\_

By: \_\_\_\_\_

(Beneficiary Agency)

(End of clause)

18 52.228-15 Performance and Payment Bonds--Construction (SEP 1996)

(a) Definitions. As used in this clause--

Contract price means the award price of the contract or, for requirements contracts, the price payable for the estimated quantity; or for indefinite-delivery type contracts, the price payable for the specified minimum quantity.

(b) Unless the resulting contract price is \$100,000 or less, the successful offeror shall be required to furnish performance and payment bonds to the Contracting Officer as follows:

(1) Performance Bonds (Standard Form 25):

(i) The penal amount of performance bonds shall be 100 percent of the original contract price.

(ii) The Government may require additional performance bond protection when the contract price is increased. The increase in protection shall generally equal 100 percent of the increase in contract price.



(iii) The Government may secure additional protection by directing the Contractor to increase the penal amount of the existing bond or to obtain an additional bond.

(2) Payment Bonds (Standard Form 25-A):

(i) The penal amount of payment bonds shall equal--

(A) 50 percent of the contract price if the contract price is not more than \$1 million;

(B) 40 percent of the contract price if the contract price is more than \$1 million but not more than \$5 million; or

(C) \$2.5 million if the contract price is more than \$5 million.

(ii) If the original contract price is \$5 million or less, the Government may require additional protection if the contract price is increased. The penal amount of the total protection shall meet the requirement of subparagraph (b)(2)(i) of this clause.

(iii) The Government may secure additional protection by directing the Contractor to increase the penal sum of the existing bond or to obtain an additional bond.

(c) The Contractor shall furnish all executed bonds, including any necessary reinsurance agreements, to the Contracting Officer, within the time period specified in the Bid Guarantee provision of the solicitation, or otherwise specified by the Contracting Officer, but in any event, before starting work.

(d) The bonds shall be in the form of firm commitment, supported by corporate sureties whose names appear on the list contained in Treasury Department Circular 570, individual sureties, or by other acceptable security such as postal money order, certified check, cashier's check, irrevocable letter of credit, or, in accordance with Treasury Department regulations, certain bonds or notes of the United States. Treasury Circular 570 is published in the Federal Register, or may be obtained from the U.S. Department of Treasury, Financial Management Service, Surety Bond Branch, 401 14th Street, NW, 2nd Floor, West Wing, Washington, DC 20227.

(End of clause)

19 52.232-18 AVAILABILITY OF FUNDS (APR 1984)

Funds are not presently available for this contract. The Government's obligation under this contract is contingent upon the availability of appropriated funds from which payment for contract purposes can be made. No legal liability on the part of the Government for any payment may arise until funds are made available to the Contracting Officer for this contract and until the Contractor receives notice of such availability, to be confirmed in writing by the Contracting Officer.

(End of clause)

(SS 7-104.91(a) 1962 SEP)

20 52.233-2 SERVICE OF PROTEST (AUG 1996)

(a) Protests, as defined in section 33.101 of the Federal Acquisition Regulation, that are filed directly with an agency, and copies of any protests that are filed with the General Accounting Office (GAO), shall be served on the Contracting Officer (addressed as follows) by obtaining written and dated acknowledgment of receipt from

Chief, Contracting Division  
Tulsa District Corps of Engineers  
Post Office Box 61  
Tulsa, OK 74121-0061

(b) The copy of any protest shall be received in the office designated above within one day of filing a protest with the GAO.

(End of provision)

21 52.236-27 SITE VISIT (CONSTRUCTION) (FEB 1995)

(a) The clauses at 52.236-2, Differing Site Conditions, and 52.236-3, Site Investigation and Conditions Affecting the Work, will be included in any contract awarded as a result of this solicitation. Accordingly, offerors or quoters are urged and expected to inspect the site where the work will be performed.

(b) Site visits may be arranged during normal duty hours by contacting:  
Name: Mr. Rick West, Resident Engineer Address: Fort Sill Resident Office  
Post Office Box 33159 Fort Sill, OK 73503-0159 Telephone: 580-355-6273

(End of provision)

22 52.204-7001 COMMERCIAL AND GOVERNMENT ENTITY (CAGE) CODE REPORTING (DEC 1991)

(a) The Offeror is requested to enter its CAGE code on its offer in the block with its name and address. The CAGE code entered must be for that name and address. Enter CAGE before the number.

(b) If the Offeror does not have a CAGE code, it may ask the Contracting Officer to request one from the Defense Logistics Services Center (DLSC). The Contracting Officer will--

(1) Ask the Contractor to complete section B of a DD Form 2051, Request for Assignment of a Commercial and Government Entity (CAGE) Code;

(2) Complete section A and forward the form to DLSC; and

(3) Notify the Contractor of its assigned CAGE code.

(c) Do not delay submission of the offer pending receipt of a CAGE code.

(End of provision)

23 52.0-4010 SMALL BUSINESS SIZE STANDARD (APR 1984) FAR 19.102

The size standard of Small Business Concerns for this procurement is a concern whose average annual sales or receipts for its preceding three fiscal years does not exceed \$17 million. Standard Industrial Classification (SIC): 1522.

(End of Clause)

24 52.0-4018 ARITHMETIC DISCREPANCIES (EFARS 52.214-5000) (MAR 1995)

(a) For the purpose of initial evaluation of bids, the following will be utilized in resolving arithmetic discrepancies found on the face of the bidding schedule as submitted by bidders:

- (1) Obviously misplaced decimal points will be corrected;
- (2) Discrepancy between unit price and extended price, the unit price will govern;
- (3) Apparent errors in extension of unit prices will be corrected; and
- (4) Apparent errors in addition of lump-sum and extended prices will be corrected.

(b) For the purpose of bid evaluation, the Government will proceed on the assumption that the bidder intends his bid to be evaluated on the basis of the unit prices, the totals arrived at by resolution of arithmetic discrepancies as provided above and the bid will be so reflected on the abstract of bids.

(c) These correction procedures shall not be used to resolve any ambiguity concerning which bid is low.

25 52.0-4023 BIDDER'S QUALIFICATIONS (APR 1984) (FAR 9.1)

Before a bid is considered for award, the bidder may be requested by the Government to submit a statement regarding his previous experience in performing comparable work, his business and technical organization, financial resources, and plant available to be used in performing the work.

26 52.0-4025 PERFORMANCE OF WORK BY CONTRACTOR

Unless he has submitted such description with his bid, the successful bidder must furnish the Contracting Officer within 14 calendar days after award a description of the work which he intends to perform with his own organization (e.g., earthwork, paving, brickwork, or roofing), the percentage of the total work this represents, and the estimated cost thereof. (See Section 00800 clause entitled "Performance of Work by Contractor.")

27 52.0-4027 NOTICE

If the work called for by this Invitation is located on a military installation, bidders should check with post/base security to learn if potential employees will be allowed on base to seek employment.

28 52.0-4045 REQUIRED BID BOND AMOUNT

Each bidder shall submit with his bid a Bid Bond (Standard Form 24) with good and sufficient surety or sureties acceptable to the Government, or other security as provided in FAR Clause 52.228-0001, Bid Guarantee, contained elsewhere in this solicitation, in the form of twenty (20) percent of the bid price or three million dollars (\$3,000,000) whichever is lesser. The bid bond penalty may be expressed in terms of a percentage of the bid price or may be expressed in dollars and cents.

(End of Clause)

29 52.0-4339 DFARS 252.204-7004 REQUIRED CENTRAL CONTRACTOR REGISTRATION (MAR 98)

(a) Definitions. As used in this clause--

(1) "Central Contractor Registration (CCR) database" means the primary DOD repository for contractor information required for the conduct of business with DOD.

(2) "Data Universal Numbering System (DUNS) number" means the 9-digit number assigned by Dun and Bradstreet Information Services to identify unique business entities.

(3) "Data Universal Numbering System +4 (DUNS+4) number" means the DUNS number assigned by Dun and Bradstreet plus a 4-digit suffix that may be assigned by a parent (controlling) business concern. This 4-digit suffix may be assigned at the discretion of the parent business concern for such purposes as identifying subunits or affiliates of the parent business concern.

(4) "Registered in the CCR database" means that all mandatory information, including the DUNS number or the DUNS+4 number, if applicable, and the corresponding Commercial and Government Entity (CAGE) code, is in the CCR database; the DUNS number and the CAGE code have been validated; and all edits have been successfully completed.

(b) (1) By submission of an offer, the offeror acknowledges the requirement that a prospective awardee must be registered in the CCR database prior to award, during performance, and through final payment of any contract resulting from this solicitation, except for awards to foreign vendors for work to be performed outside the United States.

(2) The offeror shall provide its DUNS or, if applicable, its DUNS+4 number with its offer, which will be used by the Contracting Officer to verify that the offeror is registered in the CCR database.

(3) Lack of registration in the CCR database will make an offeror ineligible for award.

(4) DOD has established a goal of registering an applicant in the CCR database within 48 hours after receipt of a complete and accurate application via the Internet. However, registration of an applicant other than the Internet may take up to 30 days. Therefore, offerors that are not registered should consider applying for registration immediately upon receipt of this solicitation.

(c) The Contractor is responsible for the accuracy and completeness of the data within the CCR, and for any liability resulting from the Government's reliance on inaccurate or incomplete data. To remain registered in the CCR database after the initial registration, the Contractor is required to confirm on an annual basis that its information in the CCR database is accurate and complete.

(d) Offerors and contractors may obtain information on registration and annual confirmation requirements by calling 1-888-227-2423, or via the Internet at <http://ccr.edi.disa.mil>.

(End of clause)

END OF SECTION 00100

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SECTION 00600

REPRESENTATIONS & CERTIFICATIONS

1 52.203-2 CERTIFICATE OF INDEPENDENT PRICE DETERMINATION (APR 1985)

(a) The offeror certifies that--

(1) The prices in this offer have been arrived at independently, without, for the purpose of restricting competition, any consultation, communication, or agreement with any other offeror or competitor relating to (i) those prices, (ii) the intention to submit an offer, or (iii) the methods or factors used to calculate the prices offered;

(2) The prices in this offer have not been and will not be knowingly disclosed by the offeror, directly or indirectly, to any other offeror or competitor before bid opening (in the case of a sealed bid solicitation) or contract award (in the case of a negotiated solicitation) unless otherwise required by law; and

(3) No attempt has been made or will be made by the offeror to induce any other concern to submit or not to submit an offer for the purpose of restricting competition.

(b) Each signature on the offer is considered to be a certification by the signatory that the signatory--

(1) Is the person in the offeror's organization responsible for determining the prices being offered in this bid or proposal, and that the signatory has not participated and will not participate in any action contrary to subparagraphs (a)(1) through (a)(3) above; or

(2)(i) Has been authorized, in writing, to act as agent for the following principals in certifying that those principals have not participated, and will not participate in any action contrary to subparagraphs (a)(1) through (a)(3) above \_\_\_\_\_

(insert full name of person(s) in the offeror's organization responsible for determining the prices offered in this bid or proposal, and the title of his or her position in the offeror's organization);

(ii) As an authorized agent, does certify that the principals named in subdivision (b)(2)(i) above have not participated, and will not participate, in any action contrary to subparagraphs (a)(1) through (a)(3) above; and

(iii) As an agent, has not personally participated, and will not participate, in any action contrary to subparagraphs (a)(1) through (a)(3) above.

(c) If the offeror deletes or modifies subparagraph (a)(2) above, the offeror must furnish with its offer a signed statement setting forth in detail the circumstances of the disclosure.

(End of provision)

2 52.203-11 CERTIFICATION AND DISCLOSURE REGARDING PAYMENTS TO INFLUENCE CERTAIN FEDERAL TRANSACTIONS (APR 1991)

(a) The definitions and prohibitions contained in the clause, at FAR 52.203-12, Limitation on Payments to Influence Certain Federal Transactions, included in this solicitation, are hereby incorporated by reference in paragraph (b) of this certification.

(b) The offeror, by signing its offer, hereby certifies to the best of his or her knowledge and belief that on or after December 23, 1989--

(1) No Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress on his or her behalf in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment or modification of any Federal contract, grant, loan, or cooperative agreement;

(2) If any funds other than Federal appropriated funds (including profit or fee received under a covered Federal transaction) have been paid, or will be paid, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress on his or her behalf in connection with this solicitation, the offeror shall complete and submit, with its offer, OMB standard form LLL, Disclosure of Lobbying Activities, to the Contracting Officer; and

(3) He or she will include the language of this certification in all subcontract awards at any tier and require that all recipients of subcontract awards in excess of \$100,000 shall certify and disclose accordingly.

(c) Submission of this certification and disclosure is a prerequisite for making or entering into this contract imposed by section 1352, title 31, United States Code. Any person who makes an expenditure prohibited under this provision or who fails to file or amend the disclosure form to be filed or amended by this provision, shall be subject to a civil penalty of not less than \$10,000, and not more than \$100,000, for each such failure.

(End of provision)

3 52. 204-3 TAXPAYER IDENTIFICATION (JUN 1997)

(a) Definitions.

"Common parent," as used in this solicitation provision, means that corporate entity that owns or controls an affiliated group of corporations that files its Federal income tax returns on a consolidated basis, and of which the offeror is a member.

"Corporate status," as used in this solicitation provision, means a designation as to whether the offeror is a corporate entity, an unincorporated entity (e. g., sole proprietorship or partnership), or a corporation providing medical and health care services.

"Taxpayer Identification Number (TIN)," as used in this solicitation provision, means the number required by the IRS to be used by the offeror in reporting income tax and other returns.

(b) All offerors are required to submit the information required in paragraphs (c) through (e) of this solicitation provision in order to comply with reporting requirements of 26 U. S. C. 6041, 6041A, and 6050M and implementing regulations issued by the Internal Revenue Service (IRS). If the resulting contract is subject to the reporting requirements described in FAR 4.903, the failure or refusal by the offeror to furnish the information may result in a 31 percent reduction of payments otherwise due under the contract.



(c) Taxpayer Identification Number (TIN).

☐ TIN: \_\_\_\_\_.

☐ TIN has been applied for.

☐ TIN is not required because:

☐ Offeror is a nonresident alien, foreign corporation, or foreign partnership that does not have income effectively connected with the conduct of a trade or business in the U.S. and does not have an office or place of business or a fiscal paying agent in the U.S.;

☐ Offeror is an agency or instrumentality of a foreign government;

☐ Offeror is an agency or instrumentality of a Federal, state, or local government;

☐ Other. State basis. \_\_\_\_\_

(d) Corporate Status.

☐ Corporation providing medical and health care services, or engaged in the billing and collecting of payments for such services;

☐ Other corporate entity;

☐ Not a corporate entity;

☐ Sole proprietorship

☐ Partnership

☐ Hospital or extended care facility described in 26 CFR 501(c)(3) that is exempt from taxation under 26 CFR 501(a).

(e) Common Parent.

☐ Offeror is not owned or controlled by a common parent as defined in paragraph (a) of this provision.

☐ Name and TIN of common parent:

Name \_\_\_\_\_

TIN \_\_\_\_\_

(End of provision)

4 52. 209-5 CERTIFICATION REGARDING DEBARMENT, SUSPENSION, PROPOSED  
DEBARMENT, AND OTHER RESPONSIBILITY MATTERS (MAR 1996)

(a)(1) The Offeror certifies, to the best of its knowledge and belief, that--

(i) The Offeror and/or any of its Principals--

(A) Are / / are not / / presently debarred, suspended, proposed for debarment, or declared ineligible for the award of contracts by any Federal agency;

(B) Have / / have not / /, within a three-year period preceding this offer, been convicted of or had a civil judgment rendered against them for: commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, state, or local) contract or subcontract; violation of Federal or state antitrust statutes relating to the submission of offers; or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, tax evasion, or receiving stolen property; and

(C) Are / / are not / / presently indicted for, or otherwise criminally or civilly charged by a governmental entity with, commission of any of the offenses enumerated in subdivision

(a)(1)(i)(B) of this provision.

(ii) The Offeror has / / has not / /, within a three-year period preceding this offer, had one or more contracts terminated for default by any Federal agency.

(2) "Principals," for the purposes of this certification, means officers; directors; owners; partners; and, persons having primary management or supervisory responsibilities within a business entity (e.g., general manager; plant manager; head of a subsidiary, division, or business segment, and similar positions).

THIS CERTIFICATION CONCERNS A MATTER WITHIN THE JURISDICTION OF AN AGENCY OF THE UNITED STATES AND THE MAKING OF A FALSE, FICTITIOUS, OR FRAUDULENT CERTIFICATION MAY RENDER THE MAKER SUBJECT TO PROSECUTION UNDER SECTION 1001, TITLE 18, UNITED STATES CODE.

(b) The Offeror shall provide immediate written notice to the Contracting Officer if, at any time prior to contract award, the Offeror learns that its certification was erroneous when submitted or has become erroneous by reason of changed circumstances.

(c) A certification that any of the items in paragraph (a) of this provision exists will not necessarily result in withholding of an award under this solicitation. However, the certification will be considered in connection with a determination of the Offeror's responsibility. Failure of the Offeror to furnish a certification or provide such additional information as requested by the Contracting Officer may render the Offeror nonresponsible.

(d) Nothing contained in the foregoing shall be construed to require establishment of a system of records in order to render, in good faith, the certification required by paragraph (a) of this provision. The knowledge and information of an Offeror is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.

(e) The certification in paragraph (a) of this provision is a material representation of fact upon which reliance was placed when making award. If it is later determined that the Offeror knowingly rendered an erroneous certification, in addition to other remedies available to the Government, the Contracting Officer may terminate the contract resulting from this solicitation for default.

(End of provision)

5 52.214-2 TYPE OF BUSINESS ORGANIZATION--SEALED BIDDING (JUL 1987)

The bidder, by checking the applicable box, represents that--

(a) It operates as ☐ a corporation incorporated under the laws of the State of \_\_\_\_\_, ☐ an individual, ☐ a partnership, ☐ a nonprofit organization, or ☐ a joint venture; or

(b) If the bidder is a foreign entity, it operates as ☐ an individual, ☐ a partnership, ☐ a nonprofit organization, ☐ a joint venture, or ☐ a corporation, registered for business in \_\_\_\_\_.

(country)

(End of provision)

6 52.219-2 EQUAL LOW BIDS (OCT 1995)

(a) This provision applies to small business concerns only.

(b) The bidder's status as a labor surplus area (LSA) concern may affect entitlement to award in case of tie bids. If the bidder wishes to be considered for this priority, the bidder must identify, in the following space, the LSA in which the costs to be incurred on account of manufacturing or production (by the bidder or the first-tier

subcontractors) amount to more than 50 percent of the contract price.

(c) Failure to identify the labor surplus areas as specified in paragraph (b) of this provision will preclude the bidder from receiving priority consideration. If the bidder is awarded a contract as a result of receiving priority consideration under this provision and would not have otherwise received award, the bidder shall perform the contract or cause the contract to be performed in accordance with the obligations of an LSA concern.

(End of provision)

7 52.219-19 SMALL BUSINESS CONCERN REPRESENTATION FOR THE SMALL BUSINESS COMPETITIVENESS DEMONSTRATION PROGRAM (JAN 1997)

(a) Definition.

"Emerging small business" as used in this solicitation, means a small business concern whose size is no greater than 50 percent of the numerical size standard applicable to the standard industrial classification code assigned to a contracting opportunity.

(b) (Complete only if the Offeror has represented itself under the provision at 52.219-1 as a small business concern under the size standards of this solicitation.)

The Offeror [ ] is, [ ] is not an emerging small business.

(c) (Complete only if the Offeror is a small business or an emerging small business, indicating its size range.)

Offeror's number of employees for the past 12 months (check this column if size standard stated in solicitation is expressed in terms of number of employees) or Offeror's average annual gross revenue for the last 3 fiscal years (check this column if size standard stated in solicitation is expressed in terms of annual receipts). (Check one of the following.)

No. of Employees	Avg. Annual Gross Revenues
___ 50 or fewer	___ \$1 million or less
___ 51-100	___ \$1,000,001-\$2 million
___ 101-250	___ \$2,000,001-\$3.5 million
___ 251-500	___ \$3,500,001-\$5 million
___ 501-750	___ \$5,000,001-\$10 million
___ 751-1,000	___ \$10,000,001-\$17 million
___ Over 1,000	___ Over \$17 million

(End of provision)

8 52.219-22 I SMALL DISADVANTAGED BUSINESS STATUS (OCT 1998) -- ALTERNATE I (OCT 1998)

(a) General. This provision is used to assess an offeror's small disadvantaged business status for the purpose of obtaining a benefit on this solicitation. Status as a small business and status as a small disadvantaged business for general statistical purposes is covered by the provision at FAR 52.219-1, Small Business Program Representation.

b) Representations.

(1) General. The offeror represents, as part of its offer, that it is a small business under the size standard applicable to this acquisition; and either--

[ ] (i) It has received certification by the Small Business Administration as a small disadvantaged business concern consistent with 13 CFR 124, Subpart B; and

(A) No material change in disadvantaged ownership and control has occurred since its certification;

(B) Where the concern is owned by one or more disadvantaged individuals, the net worth of each individual upon whom the certification is based does not exceed \$750,000 after taking into account the applicable exclusions set forth at 13 CFR 124.104

(c)(2); and

(C) It is listed, on the date of this representation, on the register of small disadvantaged business concerns maintained by the Small Business Administration; or

[ ] (ii) It has submitted a completed application to the Small Business Administration or a Private Certifier to be certified as a small disadvantaged business concern in accordance with 13 CFR 124, Subpart B, and a decision on that application is pending, and that no material change in disadvantaged ownership and control has occurred since its application was submitted.

(2) [ ] For Joint Ventures. The offeror represents, as part of its offer, that it is a joint venture that complies with the requirements at 13 CFR 124.1002(f) and that the representation in paragraph (b)(1) of this provision is accurate for the small disadvantaged business concern that is participating in the joint venture: \_\_\_\_\_.]

(3) Address. The offeror represents that its address [ ] is, [ ] is not in a region for which a small disadvantaged business procurement mechanism is authorized and its address has not changed since its certification as a small disadvantaged business concern or submission of its application for certification. The list of authorized small disadvantaged business procurement mechanisms and regions is posted at <http://www.arnet.gov/References/sdbadjustments.htm>. The offeror shall use the list in effect on the date of this solicitation. "Address," as used in this provision, means the address of the offeror as listed on the Small Business Administration's register of small disadvantaged business concerns or the address on the completed application that the concern has submitted to the Small Business Administration or a Private Certifier in accordance with 13 CFR part 124, subpart B. For joint ventures, "address" refers to the address of the small disadvantaged business concern that is participating in the joint venture.

(c) Penalties and Remedies. Anyone who misrepresents any aspects of the disadvantage status of a concern for the purposes of securing a contract or subcontract shall:

(1) Be punished by imposition of a fine, imprisonment, or both;

(2) Be subject to administrative remedies, including suspension and debarment; and

(3) Be ineligible for participation in programs conducted under the authority of the Small Business Act.

(End of provision)

9 52. 222- 21 D PROHIBITION OF SEGREGATED FACILITIES (APR 1984) (DEVIATION)

(a) "Segregated facilities," as used in this clause, means any waiting rooms, work areas, rest rooms and wash rooms, restaurants and other eating areas, time clocks, locker rooms and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing facilities provided for employees, that are segregated by explicit directive or are in fact segregated on the basis of race, color, religion, sex or national origin because of written or oral policies, or employee custom. The term does not include separate or single-user rest rooms and necessary dressing or sleeping areas, which shall be provided to assure privacy between the sexes.

(b) The Contractor agrees that it does not and will not maintain or provide for its employees any segregated facilities at any of its establishments, and that it does not and will not permit its employees to perform their services at any location under its control where segregated facilities are maintained. The Contractor agrees that a breach of this clause is a violation of the Equal Opportunity clause in this contract.

(c) The Contractor shall include this clause in every subcontract that contains the clause of this contract entitled "Equal Opportunity."  
(End of clause)

10 52. 222- 22 D PREVIOUS CONTRACTS AND COMPLIANCE REPORTS (APR 1984)  
(DEVIATION)

The offeror represents that--

(a) It ☐ has, ☐ has not, participated in a previous contract or subcontract subject to the Equal Opportunity clause of this solicitation.

(b) It ☐ has, ☐ has not filed all required compliance reports; and

(c) Representations indicating submission of required compliance reports, signed by proposed subcontractors, will be obtained before subcontract awards.

(End of provision)

11 52. 223- 1 CLEAN AIR AND WATER CERTIFICATION (APR 1984)

The Offeror certifies that--

(a) Any facility to be used in the performance of this proposed contract is ☐ is not ☐ listed on the Environmental Protection Agency (EPA) List of Violating Facilities;

(b) The Offeror will immediately notify the Contracting Officer, before award, of the receipt of any communication from the Administrator, or a designee, of the EPA, indicating that any facility that the Offeror proposes to use for the performance of the contract is under consideration to be listed on the EPA List of Violating Facilities; and

(c) The Offeror will include a certification substantially the same as this certification, including this paragraph (c), in every nonexempt subcontract.

(End of provision)  
(AV 7-2003. 71 1977 JUN)  
(AV 1-1. 2302-1)

HAZARDOUS MATERIAL IDENTIFICATION AND MATERIAL SAFETY DATA  
(JAN 1997)

(a) "Hazardous material," as used in this clause, includes any material defined as hazardous under the latest version of Federal Standard No. 313 (including revisions adopted during the term of the contract).

(b) The Offeror must list any hazardous material, as defined in paragraph (a) of this clause, to be delivered under this contract. The hazardous material shall be properly identified and include any applicable identification number, such as National Stock Number or Special Item Number. This information shall also be included on the Material Safety Data Sheet submitted under this contract.

Material  
(If none, insert None)

Identification No.


(c) This list must be updated during performance of the contract whenever the Contractor determines that any other material to be delivered under this contract is hazardous.

(d) The apparently successful Offeror agrees to submit, for each item as required prior to award, a Material Safety Data Sheet, meeting the requirements of 29 CFR 1910.1200(g) and the latest version of Federal Standard No. 313, for all hazardous material identified in paragraph (b) of this clause. Data shall be submitted in accordance with Federal Standard No. 313, whether or not the apparently successful Offeror is the actual manufacturer of these items. Failure to submit the Material Safety Data Sheet prior to award may result in the apparently successful Offeror being considered nonresponsible and ineligible for award.

(e) If, after award, there is a change in the composition of the item(s) or a revision to Federal Standard No. 313, which renders incomplete or inaccurate the data submitted under paragraph (d) of this clause, the Contractor shall promptly notify the Contracting Officer and resubmit the data.

(f) Neither the requirements of this clause nor any act or failure to act by the Government shall relieve the Contractor of any responsibility or liability for the safety of Government, Contractor, or subcontractor personnel or property.

(g) Nothing contained in this clause shall relieve the Contractor from complying with applicable Federal, State, and local laws, codes, ordinances, and regulations (including the obtaining of licenses and permits) in connection with hazardous material.

(h) The Government's rights in data furnished under this contract with respect to hazardous material are as follows:

(1) To use, duplicate and disclose any data to which this clause is applicable. The purposes of this right are to--

(i) Apprise personnel of the hazards to which they may be exposed in using, handling, packaging, transporting, or disposing of hazardous materials;

(ii) Obtain medical treatment for those affected by the material; and

(iii) Have others use, duplicate, and disclose the data for the Government for these purposes.

(2) To use, duplicate, and disclose data furnished under this clause,

in accordance with subparagraph (h)(1) of this clause, in precedence over any other clause of this contract providing for rights in data.

(3) The Government is not precluded from using similar or data acquired from other sources.

(End of clause)

13 52. 223- 13 CERTIFICATION OF TOXIC CHEMICAL RELEASE REPORTING (OCT 1996)

(a) Submission of this certification is a prerequisite for making or entering into this contract imposed by Executive Order 12969, August 8, 1995.

(b) By signing this offer, the offeror certifies that---

(1) As the owner or operator of facilities that will be used in the performance of this contract that are subject to the filing and reporting requirements described in section 313 of the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA) (42 U.S.C. 11023) and section 6607 of the Pollution Prevention Act of 1990 (PPA) (42 U.S.C. 13106), the offeror will file and continue to file for such facilities for the life of the contract the Toxic Chemical Release Inventory Form (Form R) as described in sections 313(a) and (g) of EPCRA and section 6607 of PPA; or

(2) None of its owned or operated facilities to be used in the performance of this contract is subject to the Form R filing and reporting requirements because each such facility is exempt for at least one of the following reasons: (Check each block that is applicable.)

/\_\_\_/ (i) The facility does not manufacture, process, or otherwise use any toxic chemicals listed under section 313(c) of EPCRA, 42 U.S.C. 11023(c);

/\_\_\_/ (ii) The facility does not have 10 or more full-time employees as specified in section 313(b)(1)(A) of EPCRA, 42 U.S.C. 11023(b)(1)(A);

/\_\_\_/ (iii) The facility does not meet the reporting thresholds of toxic chemicals established under section 313(f) of EPCRA, 42 U.S.C. 11023(f) (including the alternate thresholds at 40 CFR 372.27, provided an appropriate certification form has been filed with EPA);

/\_\_\_/ (iv) The facility does not fall within Standard Industrial Classification Code (SIC) designations 20 through 39 as set forth in Section 19.102 of the Federal Acquisition Regulation; or

/\_\_\_/ (v) The facility is not located within any State of the United States, the District of Columbia, the Commonwealth of Puerto Rico, Guam, American Samoa, the United States Virgin Islands, the Northern Mariana Islands, or any other territory or possession over which the United States has jurisdiction.

(End of provision)

14 52. 209- 7001 DISCLOSURE OF OWNERSHIP OR CONTROL BY THE GOVERNMENT OF A TERRORIST COUNTRY (MAR 1998)

(a) Definitions.

As used in this provision--

(1) "Government of a terrorist country" includes the state and the government of a terrorist country, as well as any political subdivision, agency, or instrumentality thereof.

(2) "Terrorist country" means a country determined by the Secretary of

State, under section 6(j)(1)(A) of the Export Administration Act of 1979 (50 U.S.C. App. 2405(j)(1)(A)), to be a country the government of which has repeatedly provided support for acts of international terrorism. As of the date of this provision, terrorist countries include: Cuba, Iran, Iraq, Libya, North Korea, Sudan, and Syria.

(3) "Significant interest" means--

(i) Ownership of or beneficial interest in 5 percent or more of the firm's or subsidiary's securities. Beneficial interest includes holding 5 percent or more of any class of the firm's securities in "nominee shares," "street names," or some other method of holding securities that does not disclose the beneficial owner;

(ii) Holding a management position in the firm, such as a director or officer;

(iii) Ability to control or influence the election, appointment, or tenure of directors or officers in the firm;

(iv) Ownership of 10 percent or more of the assets of a firm such as equipment, buildings, real estate, or other tangible assets of the firm; or

(v) Holding 50 percent or more of the indebtedness of a firm.

(b) Prohibition on award. In accordance with 10 U.S.C. 2327, no contract may be awarded to a firm or a subsidiary of a firm if the government of a terrorist country has a significant interest in the firm or subsidiary or, in the case of a subsidiary, the firm that owns the subsidiary, unless a waiver is granted by the Secretary of Defense.

(c) Disclosure.

If the government of a terrorist country has a significant interest in the Offeror or a subsidiary of the Offeror, the Offeror shall disclose such interest in an attachment to its offer. If the Offeror is a subsidiary, it shall also disclose any significant interest the government of a terrorist country has in any firm that owns or controls the subsidiary. The disclosure shall include--

(1) Identification of each government holding a significant interest; and

(2) A description of the significant interest held by each government.  
(End of provision)

15 52. 209- 7002 DISCLOSURE OF OWNERSHIP OR CONTROL BY A FOREIGN GOVERNMENT  
(SEP 1994)

(a) Definitions.

As used in this provision--

(1) Effectively owned or controlled means that a foreign government or any entity controlled by a foreign government has the power, either directly or indirectly, whether exercised or exercisable, to control the election, appointment, or tenure of the Offeror's officers or a majority of the Offeror's board of directors by any means, e.g., ownership, contract, or operation of law (or equivalent power for unincorporated organizations).

(2) Entity controlled by a foreign government--

(i) Means--

(A) Any domestic or foreign organization or corporation that is effectively owned or controlled by a foreign government; or

(B) Any individual acting on behalf of a foreign government.



(ii) Does not include an organization or corporation that is owned, but is not controlled, either directly or indirectly, by a foreign government if the ownership of that organization or corporation by that foreign government was effective before October 23, 1992.

(3) Foreign government includes the state and the government of any country (other than the United States and its possessions and trust territories) as well as any political subdivision, agency, or instrumentality thereof.

(4) "Proscribed information" means--

(i) Top Secret information;

(ii) Communications Security (COMSEC) information, except classified keys used to operate secure telephone units (STU IIIs);

(iii) Restricted Data as defined in the U. S. Atomic Energy Act of 1954, as amended;

(iv) Special Access Program (SAP) information; or

(v) Sensitive Compartmented Information (SCI).

(b) Prohibition on award.

No contract under a national security program may be awarded to an entity controlled by a foreign government if that entity requires access to proscribed information to perform the contract, unless the Secretary of Defense or a designee has waived application of 10 U. S. C. 2536(a).

(c) Disclosure.

The Offeror shall disclose any interest a foreign government has in the Offeror when that interest constitutes control by a foreign government as defined in this provision. If the Offeror is a subsidiary, it shall also disclose any reportable interest a foreign government has in any entity that owns or controls the subsidiary, including reportable interest concerning the Offeror's immediate parent, intermediate parents, and the ultimate parent. Use separate paper as needed, and provide the information in the following format:

Offeror's Point of Contact for Questions about Disclosure	
(Name and Phone Number with Country Code, City Code and Area Code, as applicable)	
Name and Address of Offeror	
Name and Address of Entity	Description of Interest,
Controlled by a Foreign	Ownership Percentage, and
Government	Identification of Foreign
	Government

(End of provision)

16 52. 225- 7031 SECONDARY ARAB BOYCOTT OF ISRAEL (JUN 1992)

(a) Definitions.

As used in this clause--

(1) "Foreign person" means any person other than a United States person as defined in section 16(2) of the Export Administration Act of 1979 (50 U. S. C. App. Sec 2415).

(2) "United States person" is defined in section 16(2) of the Export Administration Act of 1979 and means any United States resident or national (other than an individual resident outside the United States and employed by other than a United States person), any domestic concern (including any permanent domestic establishment of any foreign concern), and any foreign subsidiary or affiliate (including any permanent foreign establishment) of any domestic concern which is controlled in fact by

such domestic concern, as determined under regulations of the President.

(b) Certification.

By submitting this offer, the Offeror, if a foreign person, company or entity, certifies that it--

(1) Does not comply with the Secondary Arab Boycott of Israel; and

(2) Is not taking or knowingly agreeing to take any action, with respect to the Secondary Boycott of Israel by Arab countries, which 50 U. S. C. App. Sec 2407(a) prohibits a United States person from taking.

(End of clause)

17 52. 247- 7022 REPRESENTATION OF EXTENT OF TRANSPORTATION BY SEA (AUG 1992)

(a) The Offeror shall indicate by checking the appropriate blank in paragraph (b) of this provision whether transportation of supplies by sea is anticipated under the resultant contract. The term "supplies" is defined in the Transportation of Supplies by Sea clause of this solicitation.

(b) Representation. The Offeror represents that it--

\_\_\_\_\_ Does anticipate that supplies will be transported by sea in the performance of any contract or subcontract resulting from this solicitation.

\_\_\_\_\_ Does not anticipate that supplies will be transported by sea in the performance of any contract or subcontract resulting from this solicitation.

(c) Any contract resulting from this solicitation will include the Transportation of Supplies by Sea clause. If the Offeror represents that it will not use ocean transportation, the resulting contract will also include the Defense FAR Supplement clause at 252. 247- 7024, Notification of Transportation of Supplies by Sea.

(End of provision)

END OF SECTION 00600

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98	52. 243- 7001	PRICING OF CONTRACT MODIFICATIONS (DEC 1991)
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## SECTION 00700

### CONTRACT CLAUSES

#### 1 52.252-2 CLAUSES INCORPORATED BY REFERENCE (FEB 1998)

This contract incorporates one or more clauses by reference, with the same force and effect as if they were given in full text. Upon request, the Contracting Officer will make their full text available. Also, the full text of a clause may be accessed electronically at these addresses:

<http://www.arnet.gov/far>  
<http://farsite.hill.af.mil>  
<http://www.dtic.mil/dfars>  
(End of clause)

#### 2 52.203-9 reserved (Reference )

#### 3 52.202-1 DEFINITIONS (OCT 1995)

(a) "Head of the agency" (also called "agency head") or "Secretary" means the Secretary (or Attorney General, Administrator, Governor, Chairperson, or other chief official, as appropriate) of the agency, including any deputy or assistant chief official of the agency; and the term "authorized representative" means any person, persons, or board (other than the Contracting Officer) authorized to act for the head of the agency or Secretary.

(b) Commercial component means any component that is a commercial item

(c) Commercial item means--

(1) Any item, other than real property, that is of a type customarily used for nongovernmental purposes and that--

(i) Has been sold, leased, or licensed to the general public; or

(ii) Has been offered for sale, lease, or license to the general public;

(2) Any item that evolved from an item described in paragraph (c)(1) of this clause through advances in technology or performance and that is not yet available in the commercial marketplace, but will be available in the commercial marketplace in time to satisfy the delivery requirements under a Government solicitation;

(3) Any item that would satisfy a criterion expressed in paragraphs (c)(1) or (c)(2) of this clause, but for--

(i) Modifications of a type customarily available in the commercial marketplace; or

(ii) Minor modifications of a type not customarily available in the commercial marketplace made to meet Federal Government requirements.

"Minor" modifications means modifications that do not significantly alter the nongovernmental function or essential physical characteristics of an item or component, or change the purpose of a process. Factors to be considered in determining whether a modification is minor include the value and size of the modification and the comparative value and size of the final product. Dollar values

and percentages may be used as guideposts, but are not conclusive evidence that a modification is minor;

(4) Any combination of items meeting the requirements of paragraphs (c)(1), (2), (3), or (5) of this clause that are of a type customarily combined and sold in combination to the general public;

(5) Installation services, maintenance services, repair services, training services, and other services if such services are procured for support of an item referred to in paragraphs (c)(1), (2), (3), or (4) of this clause, and if the source of such services--

(i) Offers such services to the general public and the Federal Government contemporaneously and under similar terms and conditions; and

(ii) Offers to use the same work force for providing the Federal Government with such services as the source uses for providing such services to the general public;

(6) Services of a type offered and sold competitively in substantial quantities in the commercial marketplace based on established catalog or market prices for specific tasks performed under standard commercial terms and conditions. This does not include services that are sold based on hourly rates without an established catalog or market price for a specific service performed;

(7) Any item, combination of items, or service referred to in subparagraphs (c)(1) through (c)(6), notwithstanding the fact that the item, combination of items, or service is transferred between or among separate divisions, subsidiaries, or affiliates of a Contractor; or

(8) A nondevelopmental item, if the procuring agency determines the item was developed exclusively at private expense and sold in substantial quantities, on a competitive basis, to multiple State and local Governments.

(d) Component means any item supplied to the Federal Government as part of an end item or of another component.

(e) Nondevelopmental item means--

(1) Any previously developed item of supply used exclusively for governmental purposes by a Federal agency, a State or local government, or a foreign government with which the United States has a mutual defense cooperation agreement;

(2) Any item described in paragraph (e)(1) of this definition that requires only minor modification or modifications of a type customarily available in the commercial marketplace in order to meet the requirements of the procuring department or agency; or

(3) Any item of supply being produced that does not meet the requirements of paragraph (e)(1) or (e)(2) solely because the item is not yet in use.

(f) "Contracting Officer" means a person with the authority to enter into, administer, and/or terminate contracts and make related determinations and findings. The term includes certain authorized representatives of the Contracting Officer acting within the limits of their authority as delegated by the Contracting Officer.

(g) Except as otherwise provided in this contract, the term "subcontracts" includes, but is not limited to, purchase orders and changes and modifications to purchase orders under this contract.

(End of clause)

4 52. 203- 3 GRATUITIES (APR 1984)

(a) The right of the Contractor to proceed may be terminated by written notice if, after notice and hearing, the agency head or a designee determines that the Contractor, its agent, or another representative--

(1) Offered or gave a gratuity (e.g., an entertainment or gift) to an officer, official, or employee of the Government; and

(2) Intended, by the gratuity, to obtain a contract or favorable treatment under a contract.

(b) The facts supporting this determination may be reviewed by any court having lawful jurisdiction.

(c) If this contract is terminated under paragraph (a) above, the Government is entitled--

(1) To pursue the same remedies as in a breach of the contract; and

(2) In addition to any other damages provided by law, to exemplary damages of not less than 3 nor more than 10 times the cost incurred by the Contractor in giving gratuities to the person concerned, as determined by the agency head or a designee. (This subparagraph (c) (2) is applicable only if this contract uses money appropriated to the Department of Defense.)

(d) The rights and remedies of the Government provided in this clause shall not be exclusive and are in addition to any other rights and remedies provided by law or under this contract.

(End of clause)

(R 7-104.16 1952 MAR)

5 52. 203- 5 COVENANT AGAINST CONTINGENT FEES (APR 1984)

(a) The Contractor warrants that no person or agency has been employed or retained to solicit or obtain this contract upon an agreement or understanding for a contingent fee, except a bona fide employee or agency. For breach or violation of this warranty, the Government shall have the right to annul this contract without liability or, in its discretion, to deduct from the contract price or consideration, or otherwise recover, the full amount of the contingent fee.

(b) "Bona fide agency," as used in this clause, means an established commercial or selling agency, maintained by a contractor for the purpose of securing business, that neither exerts nor proposes to exert improper influence to solicit or obtain Government contracts nor holds itself out as being able to obtain any Government contract or contracts through improper influence.

"Bona fide employee," as used in this clause, means a person, employed by a Contractor and subject to the Contractor's supervision and control as to time, place, and manner of performance, who neither exerts nor proposes to exert improper influence to solicit or obtain Government contracts nor holds out as being able to obtain any Government contract or contracts through improper influence.

"Contingent fee," as used in this clause, means any commission, percentage, brokerage, or other fee that is contingent upon the success that a person or concern has in securing a Government contract.

"Improper influence," as used in this clause, means any influence that



induces or tends to induce a Government employee or officer to give consideration or to act regarding a Government contract on any basis other than the merits of the matter.

(End of clause)  
(R 7-103.20 1958 JAN)  
(R 1-1.503)  
(R 1-7.102-18)

6 52.203-6 RESTRICTIONS ON SUBCONTRACTOR SALES TO THE GOVERNMENT  
(JUL 1995)

(a) Except as provided in (b) below, the Contractor shall not enter into any agreement with an actual or prospective subcontractor, nor otherwise act in any manner, which has or may have the effect of restricting sales by such subcontractors directly to the Government of any item or process (including computer software) made or furnished by the subcontractor under this contract or under any follow-on production contract.

(b) The prohibition in (a) above does not preclude the Contractor from asserting rights that are otherwise authorized by law or regulation.

(c) The Contractor agrees to incorporate the substance of this clause, including this paragraph (c), in all subcontracts under this contract which exceed \$100,000.

(End of clause)

7 52.203-7 ANTI-KICKBACK PROCEDURES (JUL 1995)

(a) Definitions.

"Kickback," as used in this clause, means any money, fee, commission, credit, gift, gratuity, thing of value, or compensation of any kind which is provided, directly or indirectly, to any prime Contractor, prime Contractor employee, subcontractor, or subcontractor employee for the purpose of improperly obtaining or rewarding favorable treatment in connection with a prime contract or in connection with a subcontract relating to a prime contract.

"Person," as used in this clause, means a corporation, partnership, business association of any kind, trust, joint-stock company, or individual.

"Prime contract," as used in this clause, means a contract or contractual action entered into by the United States for the purpose of obtaining supplies, materials, equipment, or services of any kind.

"Prime Contractor" as used in this clause, means a person who has entered into a prime contract with the United States.

"Prime Contractor employee," as used in this clause, means any officer, partner, employee, or agent of a prime Contractor.

"Subcontract," as used in this clause, means a contract or contractual action entered into by a prime Contractor or subcontractor for the purpose of obtaining supplies, materials, equipment, or services of any kind under a prime contract.

"Subcontractor," as used in this clause, (1) means any person, other than the prime Contractor, who offers to furnish or furnishes any

supplies, materials, equipment, or services of any kind under a prime contract or a subcontract entered into in connection with such prime contract, and (2) includes any person who offers to furnish or furnishes general supplies to the prime Contractor or a higher tier subcontractor.

"Subcontractor employee," as used in this clause, means any officer, partner, employee, or agent of a subcontractor.

(b) The Anti-Kickback Act of 1986 (41 U.S.C. 51-58) (the Act), prohibits any person from -

(1) Providing or attempting to provide or offering to provide any kickback;

(2) Soliciting, accepting, or attempting to accept any kickback; or

(3) Including, directly or indirectly, the amount of any kickback in the contract price charged by a prime Contractor to the United States or in the contract price charged by a subcontractor to a prime Contractor or higher tier subcontractor.

(c)(1) The Contractor shall have in place and follow reasonable procedures designed to prevent and detect possible violations described in paragraph (b) of this clause in its own operations and direct business relationships.

(2) When the Contractor has reasonable grounds to believe that a violation described in paragraph (b) of this clause may have occurred, the Contractor shall promptly report in writing the possible violation. Such reports shall be made to the inspector general of the contracting agency, the head of the contracting agency if the agency does not have an inspector general, or the Department of Justice.

(3) The Contractor shall cooperate fully with any Federal agency investigating a possible violation described in paragraph (b) of this clause.

(4) The Contracting Officer may (i) offset the amount of the kickback against any monies owed by the United States under the prime contract and/or (ii) direct that the Prime Contractor withhold from sums owed a subcontractor under the prime contract the amount of the kickback. The Contracting Officer may order that monies withheld under subdivision (c)(4)(ii) of this clause be paid over to the Government unless the Government has already offset those monies under subdivision (c)(4)(i) of this clause. In either case, the Prime Contractor shall notify the Contracting Officer when the monies are withheld.

(5) The Contractor agrees to incorporate the substance of this clause, including subparagraph (c)(5) but excepting subparagraph (c)(1), in all subcontracts under this contract which exceed \$100,000.

(End of clause)

8 52.203-8 CANCELLATION, RESCISSION, AND RECOVERY OF FUNDS FOR ILLEGAL OR IMPROPER ACTIVITY (JAN 1997)

(a) If the Government receives information that a contractor or a person has engaged in conduct constituting a violation of subsection (a), (b), (c), or (d) of Section 27 of the Office of Federal Procurement Policy Act (41 U.S.C. 423) (the Act), as amended by section 4304 of the National Defense Authorization Act for Fiscal Year 1996 (Pub. L. 104-106), the Government may--

(1) Cancel the solicitation, if the contract has not yet been awarded or issued; or

(2) Rescind the contract with respect to which--

(i) The Contractor or someone acting for the Contractor has been convicted for an offense where the conduct constitutes a violation of subsection 27 (a) or (b) of the Act for the purpose of either--

(A) Exchanging the information covered by such subsections for anything of value; or

(B) Obtaining or giving anyone a competitive advantage in the award of a Federal agency procurement contract; or

(ii) The head of the contracting activity has determined, based upon a preponderance of the evidence, that the Contractor or someone acting for the Contractor has engaged in conduct constituting an offense punishable under subsection 27(e)(1) of the Act.

(b) If the Government rescinds the contract under paragraph (a) of this clause, the Government is entitled to recover, in addition to any penalty prescribed by law, the amount expended under the contract.

(c) The rights and remedies of the Government specified herein are not exclusive, and are in addition to any other rights and remedies provided by law, regulation, or under this contract.

(End of clause)

9 52. 203- 10 PRICE OR FEE ADJUSTMENT FOR ILLEGAL OR IMPROPER ACTIVITY  
(JAN 1997)

(a) The Government, at its election, may reduce the price of a fixed-price type contract and the total cost and fee under a cost-type contract by the amount of profit or fee determined as set forth in paragraph (b) of this clause if the head of the contracting activity or designee determines that there was a violation of subsection 27 (a), (b), or (c) of the Office of Federal Procurement Policy Act, as amended (41 U. S. C. 423), as implemented in section 3.104 of the Federal Acquisition Regulation.

(b) The price or fee reduction referred to in paragraph (a) of this clause shall be--

(1) For cost-plus-fixed-fee contracts, the amount of the fee specified in the contract at the time of award;

(2) For cost-plus-incentive-fee contracts, the target fee specified in the contract at the time of award, notwithstanding any minimum fee or "fee floor" specified in the contract;

(3) For cost-plus-award-fee contracts--

(i) The base fee established in the contract at the time of contract award;

(ii) If no base fee is specified in the contract, 30 percent of the amount of each award fee otherwise payable to the Contractor for each award fee evaluation period or at each award fee determination point.

(4) For fixed-price-incentive contracts, the Government may--

(i) Reduce the contract target price and contract target profit both by an amount equal to the initial target profit specified in the contract at the time of contract award; or

(ii) If an immediate adjustment to the contract target price and

contract target profit would have a significant adverse impact on the incentive price revision relationship under the contract, or adversely affect the contract financing provisions, the Contracting Officer may defer such adjustment until establishment of the total final price of the contract. The total final price established in accordance with the incentive price revision provisions of the contract shall be reduced by an amount equal to the initial target profit specified in the contract at the time of contract award and such reduced price shall be the total final contract price.

(5) For firm-fixed-price contracts, by 10 percent of the initial contract price or a profit amount determined by the Contracting Officer from records or documents in existence prior to the date of the contract award.

(c) The Government may, at its election, reduce a prime contractor's price or fee in accordance with the procedures of paragraph (b) of this clause for violations of the Act by its subcontractors by an amount not to exceed the amount of profit or fee reflected in the subcontract at the time the subcontract was first definitively priced.

(d) In addition to the remedies in paragraphs (a) and (c) of this clause, the Government may terminate this contract for default. The rights and remedies of the Government specified herein are not exclusive, and are in addition to any other rights and remedies provided by law or under this contract.

(End of clause)

10 52.203-12 LIMITATION ON PAYMENTS TO INFLUENCE CERTAIN FEDERAL  
TRANSACTIONS (JUN 1997)

(a) Definitions.

"Agency," as used in this clause, means executive agency as defined in 2.101.

"Covered Federal action," as used in this clause, means any of the following Federal actions:

- (1) The awarding of any Federal contract.
- (2) The making of any Federal grant.
- (3) The making of any Federal loan.
- (4) The entering into of any cooperative agreement.
- (5) The extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

"Indian tribe" and "tribal organization," as used in this clause, have the meaning provided in section 4 of the Indian Self-Determination and Education Assistance Act (25 U.S.C. 450B) and include Alaskan Natives.

"Influencing or attempting to influence," as used in this clause, means making, with the intent to influence, any communication to or appearance before an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with any covered Federal action.

"Local government," as used in this clause, means a unit of government in a State and, if chartered, established, or otherwise recognized by a State for the performance of a governmental duty, including a local public authority, a special district, an intrastate district, a council of

governments, a sponsor group representative organization, and any other instrumentality of a local government.

"Officer or employee of an agency," as used in this clause, includes the following individuals who are employed by an agency:

(1) An individual who is appointed to a position in the Government under title 5, United States Code, including a position under a temporary appointment.

(2) A member of the uniformed services, as defined in subsection 101(3), title 37, United States Code.

(3) A special Government employee, as defined in section 202, title 18, United States Code.

(4) An individual who is a member of a Federal advisory committee, as defined by the Federal Advisory Committee Act, title 5, United States Code, appendix 2.

"Person," as used in this clause, means an individual, corporation, company, association, authority, firm, partnership, society, State, and local government, regardless of whether such entity is operated for profit, or not for profit. This term excludes an Indian tribe, tribal organization, or any other Indian organization with respect to expenditures specifically permitted by other Federal law.

"Reasonable compensation," as used in this clause, means, with respect to a regularly employed officer or employee of any person, compensation that is consistent with the normal compensation for such officer or employee for work that is not furnished to, not funded by, or not furnished in cooperation with the Federal Government.

"Reasonable payment," as used in this clause, means, with respect to professional and other technical services, a payment in an amount that is consistent with the amount normally paid for such services in the private sector.

"Recipient," as used in this clause, includes the Contractor and all subcontractors. This term excludes an Indian tribe, tribal organization, or any other Indian organization with respect to expenditures specifically permitted by other Federal law.

"Regularly employed," as used in this clause, means, with respect to an officer or employee of a person requesting or receiving a Federal contract, an officer or employee who is employed by such person for at least 130 working days within 1 year immediately preceding the date of the submission that initiates agency consideration of such person for receipt of such contract. An officer or employee who is employed by such person for less than 130 working days within 1 year immediately preceding the date of the submission that initiates agency consideration of such person shall be considered to be regularly employed as soon as he or she is employed by such person for 130 working days.

"State," as used in this clause, means a State of the United States, the District of Columbia, the Commonwealth of Puerto Rico, a territory or possession of the United States, an agency or instrumentality of a State, and multi-State, regional, or interstate entity having governmental duties and powers.

(b) Prohibitions.

(1) Section 1352 of title 31, United States Code, among other things, prohibits a recipient of a Federal contract, grant, loan, or cooperative agreement from using appropriated funds to pay any person for influencing

or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with any of the following covered Federal actions: the awarding of any Federal contract; the making of any Federal grant; the making of any Federal loan; the entering into of any cooperative agreement; or the modification of any Federal contract, grant, loan, or cooperative agreement.

(2) The Act also requires Contractors to furnish a disclosure if any funds other than Federal appropriated funds (including profit or fee received under a covered Federal transaction) have been paid, or will be paid, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with a Federal contract, grant, loan, or cooperative agreement.

(3) The prohibitions of the Act do not apply under the following conditions:

(i) Agency and legislative liaison by own employees.

(A) The prohibition on the use of appropriated funds, in subparagraph (b)(1) of this clause, does not apply in the case of a payment of reasonable compensation made to an officer or employee of a person requesting or receiving a covered Federal action if the payment is for agency and legislative liaison activities not directly related to a covered Federal action.

(B) For purposes of subdivision (b)(3)(i)(A) of this clause, providing any information specifically requested by an agency or Congress is permitted at any time.

(C) The following agency and legislative liaison activities are permitted at any time where they are not related to a specific solicitation for any covered Federal action:

(1) Discussing with an agency the qualities and characteristics (including individual demonstrations) of the person's products or services, conditions or terms of sale, and service capabilities.

(2) Technical discussions and other activities regarding the application or adaptation of the person's products or services for an agency's use.

(D) The following agency and legislative liaison activities are permitted where they are prior to formal solicitation of any covered Federal action--

(1) Providing any information not specifically requested but necessary for an agency to make an informed decision about initiation of a covered Federal action;

(2) Technical discussions regarding the preparation of an unsolicited proposal prior to its official submission; and

(3) Capability presentations by persons seeking awards from an agency pursuant to the provisions of the Small Business Act, as amended by Pub. L. 95-507, and subsequent amendments.

(E) Only those services expressly authorized by subdivision (b)(3)(i)(A) of this clause are permitted under this clause.

(ii) Professional and technical services.

(A) The prohibition on the use of appropriated funds, in subparagraph (b)(1) of this clause, does not apply in the case of--

(1) A payment of reasonable compensation made to an officer or

employee of a person requesting or receiving a covered Federal action or an extension, continuation, renewal, amendment, or modification of a covered Federal action, if payment is for professional or technical services rendered directly in the preparation, submission, or negotiation of any bid, proposal, or application for that Federal action or for meeting requirements imposed by or pursuant to law as a condition for receiving that Federal action.

(2) Any reasonable payment to a person, other than an officer or employee of a person requesting or receiving a covered Federal action or an extension, continuation, renewal, amendment, or modification of a covered Federal action if the payment is for professional or technical services rendered directly in the preparation, submission, or negotiation of any bid, proposal, or application for that Federal action or for meeting requirements imposed by or pursuant to law as a condition for receiving that Federal action. Persons other than officers or employees of a person requesting or receiving a covered Federal action include consultants and trade associations.

(B) For purposes of subdivision (b)(3)(ii)(A) of this clause, "professional and technical services" shall be limited to advice and analysis directly applying any professional or technical discipline. For example, drafting of a legal document accompanying a bid or proposal by a lawyer is allowable. Similarly, technical advice provided by an engineer on the performance or operational capability of a piece of equipment rendered directly in the negotiation of a contract is allowable. However, communications with the intent to influence made by a professional (such as a licensed lawyer) or a technical person (such as a licensed accountant) are not allowable under this section unless they provide advice and analysis directly applying their professional or technical expertise and unless the advice or analysis is rendered directly and solely in the preparation, submission or negotiation of a covered Federal action. Thus, for example, communications with the intent to influence made by a lawyer that do not provide legal advice or analysis directly and solely related to the legal aspects of his or her client's proposal, but generally advocate one proposal over another are not allowable under this section because the lawyer is not providing professional legal services. Similarly, communications with the intent to influence made by an engineer providing an engineering analysis prior to the preparation or submission of a bid or proposal are not allowable under this section since the engineer is providing technical services but not directly in the preparation, submission or negotiation of a covered Federal action.

(C) Requirements imposed by or pursuant to law as a condition for receiving a covered Federal award include those required by law or regulation and any other requirements in the actual award documents.

(D) Only those services expressly authorized by subdivisions (b)(3)(ii)(A)(1) and (2) of this clause are permitted under this clause.

(E) The reporting requirements of FAR 3.803(a) shall not apply with respect to payments of reasonable compensation made to regularly employed officers or employees of a person.

(c) Disclosure.

(1) The Contractor who requests or receives from an agency a Federal contract shall file with that agency a disclosure form, OMB standard form LLL, Disclosure of Lobbying Activities, if such person has made or has agreed to make any payment using nonappropriated funds (to include profits from any covered Federal action), which would be prohibited under subparagraph (b)(1) of this clause, if paid for with appropriated funds.

(2) The Contractor shall file a disclosure form at the end of each calendar quarter in which there occurs any event that materially affects the accuracy of the information contained in any disclosure form previously filed by such person under subparagraph (c)(1) of this clause. An event that materially affects the accuracy of the information reported includes--

(i) A cumulative increase of \$25,000 or more in the amount paid or expected to be paid for influencing or attempting to influence a covered Federal action; or

(ii) A change in the person(s) or individual(s) influencing or attempting to influence a covered Federal action; or

(iii) A change in the officer(s), employee(s), or Member(s) contacted to influence or attempt to influence a covered Federal action.

(3) The Contractor shall require the submittal of a certification, and if required, a disclosure form by any person who requests or receives any subcontract exceeding \$100,000 under the Federal contract.

(4) All subcontractor disclosure forms (but not certifications) shall be forwarded from tier to tier until received by the prime Contractor. The prime Contractor shall submit all disclosures to the Contracting Officer at the end of the calendar quarter in which the disclosure form is submitted by the subcontractor. Each subcontractor certification shall be retained in the subcontract file of the awarding Contractor.

(d) Agreement. The Contractor agrees not to make any payment prohibited by this clause.

(e) Penalties.

(1) Any person who makes an expenditure prohibited under paragraph (a) of this clause or who fails to file or amend the disclosure form to be filed or amended by paragraph (b) of this clause shall be subject to civil penalties as provided for by 31 U.S.C. 1352. An imposition of a civil penalty does not prevent the Government from seeking any other remedy that may be applicable.

(2) Contractors may rely without liability on the representation made by their subcontractors in the certification and disclosure form.

(f) Cost allowability. Nothing in this clause makes allowable or reasonable any costs which would otherwise be unallowable or unreasonable. Conversely, costs made specifically unallowable by the requirements in this clause will not be made allowable under any other provision.

(End of clause)



11 52.204-4 PRINTING/COPYING DOUBLE-SIDED ON RECYCLED PAPER (JUN 1996)

(a) In accordance with Executive Order 12873, dated October 20, 1993, as amended by Executive Order 12995, dated March 25, 1996, the Offeror/Contractor is encouraged to submit paper documents, such as offers, letters, or reports, that are printed/copied double-sided on recycled paper that has at least 20 percent postconsumer material.

(b) The 20 percent standard applies to high-speed copier paper, offset paper, forms bond, computer printout paper, carbonless paper, file folders, white woven envelopes, and other uncoated printed and writing paper, such as writing and office paper, book paper, cotton fiber paper, and cover stock. An alternative to meeting the 20 percent postconsumer material standard is 50 percent recovered material content of certain industrial by-products.

(End of clause)

12 52.209-6 PROTECTING THE GOVERNMENT'S INTEREST WHEN SUBCONTRACTING WITH CONTRACTORS DEBARRED, SUSPENDED, OR PROPOSED FOR DEBARMENT (JUL 1995)

(a) The Government suspends or debar Contractors to protect the Government's interest. The Contractor shall not enter into any subcontract in excess of \$25,000 with a Contractor that is debarred, suspended, or proposed for debarment unless there is a compelling reason to do so.

(b) The Contractor shall require each proposed first-tier subcontractor, whose subcontract will exceed \$25,000, to disclose to the Contractor, in writing, whether as of the time of award of the subcontract, the subcontractor, or its principals, is or is not debarred, suspended, or proposed for debarment by the Federal Government.

(c) A corporate officer or a designee of the Contractor shall notify the Contracting Officer, in writing, before entering into a subcontract with a party that is debarred, suspended, or proposed for debarment (see FAR 9.404 for information on the List of Parties Excluded from Federal Procurement and Nonprocurement Programs). The notice must include the following:

(1) The name of the subcontractor.

(2) The Contractor's knowledge of the reasons for the subcontractor being on the List of Parties Excluded from Federal Procurement and Nonprocurement Programs.

(3) The compelling reason(s) for doing business with the subcontractor notwithstanding its inclusion on the List of Parties Excluded from Federal Procurement and Nonprocurement Programs.

(4) The systems and procedures the Contractor has established to ensure that it is fully protecting the Government's interests when dealing with such subcontractor in view of the specific basis for the party's debarment, suspension, or proposed debarment.

(End of clause)

13 52.211-2 AVAILABILITY OF SPECIFICATIONS LISTED IN THE DOD INDEX OF  
SPECIFICATIONS AND STANDARDS (DODISS) AND DESCRIPTIONS LISTED  
IN THE ACQUISITION MANAGEMENT SYSTEMS AND DATA REQUIREMENTS  
CONTROL LIST, DOD 5010.12-L (AUG 1998)

(a) Copies of specifications, standards, and data item descriptions cited in this solicitation may be obtained for a fee by submitting a request to the--Department of Defense Single Stock Point (DoDSSP), Building 4, Section D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Telephone (215) 697-2667/2179, Facsimile (215) 697-1462.

(b) Order forms, pricing information, and customer support information may be obtained--

(1) By telephone at (215) 697-2667/2179; or

(2) Through the DoDSSP Internet site at <http://www.dodssp.daps.mil>.

(End of provision)

14 52.211-15 DEFENSE PRIORITY AND ALLOCATION REQUIREMENTS (SEP 1990)

This is a rated order certified for national defense use, and the Contractor shall follow all the requirements of the Defense Priorities and Allocations System regulation (15 CFR 700).

(End of clause)

15 52.214-26 AUDIT AND RECORDS--SEALED BIDDING (OCT 1997)

(a) As used in this clause, records includes books, documents, accounting procedures and practices, and other data, regardless of type and regardless of whether such items are in written form, in the form of computer data, or in any other form.

(b) Cost or pricing data. If the Contractor has been required to submit cost or pricing data in connection with the pricing of any modification to this contract, the Contracting Officer, or an authorized representative of the Contracting Officer, in order to evaluate the accuracy, completeness, and currency of the cost or pricing data, shall have the right to examine and audit all of the Contractor's records, including computations and projections, related to--

(1) The proposal for the modification;

(2) The discussions conducted on the proposal(s), including those related to negotiating;

(3) Pricing of the modification; or

(4) Performance of the modification.

(c) Comptroller General. In the case of pricing any modification, the Comptroller General of the United States, or an authorized representative, shall have the same rights as specified in paragraph (b) of this clause.

(d) Availability. The Contractor shall make available at its office at all reasonable times the materials described in reproduction, until 3 years after final payment under this contract, or for any other period specified in Subpart 4.7 of the Federal Acquisition Regulation (FAR). FAR Subpart 4.7, Contractor Records Retention, in effect on the date of this contract, is incorporated by reference in its entirety and made a part of this

contract.

(1) If this contract is completely or partially terminated, the records relating to the work terminated shall be made available for 3 years after any resulting final termination settlement.

(2) Records pertaining to appeals under the Disputes clause or to litigation or the settlement of claims arising under or relating to the performance of this contract shall be made available until disposition of such appeals, litigation, or claims.

(e) The Contractor shall insert a clause containing all the provisions of this clause, including this paragraph (e), in all subcontracts expected to exceed the threshold in FAR 15.403-4(a)(1) for submission of cost or pricing data.

(End of clause)

16 52.214-27 PRICE REDUCTION FOR DEFECTIVE COST OR PRICING DATA--  
MODIFICATIONS--SEALED BIDDING (OCT 1997)

(a) This clause shall become operative only for any modification to this contract involving aggregate increases and/or decreases in costs, plus applicable profits, expected to exceed the threshold for the submission of cost or pricing data at FAR 15.403-4(a)(1), except that this clause does not apply to a modification if an exception under FAR 15.403-1(b) applies.

(b) If any price, including profit, negotiated in connection with any modification under this clause, was increased by any significant amount because (1) the Contractor or a subcontractor furnished cost or pricing data that were not complete, accurate, and current as certified in its Certificate of Current Cost or Pricing Data, (2) a subcontractor or prospective subcontractor furnished the Contractor cost or pricing data that were not complete, accurate, and current as certified in the Contractor's Certificate of Current Cost or Pricing Data, or (3) any of these parties furnished data of any description that were not accurate, the price shall be reduced accordingly and the contract shall be modified to reflect the reduction. This right to a price reduction is limited to that resulting from defects in data relating to modifications for which this clause becomes operative under paragraph (a) above.

(c) Any reduction in the contract price under paragraph (b) above due to defective data from a prospective subcontractor that was not subsequently awarded the subcontract shall be limited to the amount, plus applicable overhead and profit markup, by which (1) the actual subcontract or (2) the actual cost to the Contractor, if there was no subcontract, was less than the prospective subcontract cost estimate submitted by the Contractor; provided, that the actual subcontract price was not itself affected by defective cost or pricing data.

(d)(1) If the Contracting Officer determines under paragraph (b) of this clause that a price or cost reduction should be made, the Contractor agrees not to raise the following matters as a defense:

(i) The Contractor or subcontractor was a sole source supplier or otherwise was in a superior bargaining position and thus the price of the contract would not have been modified even if accurate, complete, and current cost or pricing data had been submitted.

(ii) The Contracting Officer should have known that the cost or

pricing data in issue were defective even though the Contractor or subcontractor took no affirmative action to bring the character of the data to the attention of the Contracting Officer.

(iii) The contract was based on an agreement about the total cost of the contract and there was no agreement about the cost of each item procured under the contract.

(iv) The Contractor or subcontractor did not submit a Certificate of Current Cost or Pricing Data.

(2)(i) Except as prohibited by subdivision (d)(2)(ii) of this clause, an offset in an amount determined appropriate by the Contracting Officer based upon the facts shall be allowed against the amount of a contract price reduction if--

(A) The Contractor certifies to the Contracting Officer that, to the best of the Contractor's knowledge and belief, the Contractor is entitled to the offset in the amount requested; and

(B) The Contractor proves that the cost or pricing data were available before the date of agreement on the price of the contract (or price of the modification) and that the data were not submitted before such date.

(ii) An offset shall not be allowed if--

(A) The understated data was known by the Contractor to be understated when the Certificate of Current Cost or Pricing Data was signed; or

(B) The Government proves that the facts demonstrate that the contract price would not have increased in the amount to be offset even if the available data had been submitted before the date of agreement on price.

(e) If any reduction in the contract price under this clause reduces the price of items for which payment was made prior to the date of the modification reflecting the price reduction, the Contractor shall be liable to and shall pay the United States at the time such overpayment is repaid--

(1) Simple interest on the amount of such overpayment to be computed from the date(s) of overpayment to the Contractor to the date the Government is repaid by the Contractor at the applicable underpayment rate effective for each quarter prescribed by the Secretary of the Treasury under 26 U. S. C. 6621(a)(2); and

(2) A penalty equal to the amount of the overpayment, if the Contractor or subcontractor knowingly submitted cost or pricing data which were incomplete, inaccurate, or noncurrent.

(End of clause)

17 52.214-28 SUBCONTRACTOR COST OR PRICING DATA--MODIFICATIONS--SEALED  
BIDDING (OCT 1997)

(a) The requirements of paragraphs (b) and (c) of this clause shall (1) become operative only for any modification to this contract involving aggregate increases and/or decreases in costs, plus applicable profits, expected to exceed the threshold for submission of cost or pricing data at FAR 15.403-4(a)(1), and (2) be limited to such modifications.

(b) Before awarding any subcontract expected to exceed the threshold for submission of cost or pricing data at FAR 15.403-4(a)(1), on the date of

(c) The Contractor shall require the subcontractor to certify in substantially the form prescribed in subsection FAR 15.406-2 that, to the best of its knowledge and belief, the data submitted under paragraph (b) of this clause were accurate, complete, and current as of the date of agreement on the negotiated price of the subcontract or subcontract modification.

(End of clause)

**18      52. 214- 29**

(End of clause)

19 52. 219-8

(b) The Contractor hereby agrees to carry out this policy in the awarding of subcontracts to the fullest extent consistent with efficient contract performance. The Contractor further agrees to cooperate in any studies or surveys as may be conducted by the United States Small Business Administration or the awarding agency of the United States as may be necessary to determine the extent of the Contractor's compliance with this clause.

(c) As used in this contract, the term "small business concern" shall

mean a small business as defined pursuant to section 3 of the Small Business Act and relevant regulations promulgated pursuant thereto. The term "small business concern owned and controlled by socially and economically disadvantaged individuals" shall mean a small business concern (1) which is at least 51 percent unconditionally owned by one or more socially and economically disadvantaged individuals; or, in the case of any publicly owned business, at least 51 per centum of the stock of which is unconditionally owned by one or more socially and economically disadvantaged individuals; and (2) whose management and daily business operations are controlled by one or more of such individuals. This term also means a small business concern that is at least 51 percent unconditionally owned by an economically disadvantaged Indian tribe or Native Hawaiian Organization, or a publicly owned business having at least 51 percent of its stock unconditionally owned by one of these entities which has its management and daily business controlled by members of an economically disadvantaged Indian tribe or Native Hawaiian Organization, and which meets the requirements of 13 CFR 124. The Contractor shall presume that socially and economically disadvantaged individuals include Black Americans, Hispanic Americans, Native Americans, Asian-Pacific Americans, Subcontinent Asian Americans, and other minorities, or any other individual found to be disadvantaged by the Administration pursuant to section 8(a) of the Small Business Act. The Contractor shall presume that socially and economically disadvantaged entities also include Indian Tribes and Native Hawaiian Organizations.

(d) The term "small business concern owned and controlled by women" shall mean a small business concern (1) which is at least 51 percent owned by one or more women, or, in the case of any publicly owned business, at least 51 percent of the stock of which is owned by one or more women, and (2) whose management and daily business operations are controlled by one or more women; and

(e) Contractors acting in good faith may rely on written representations by their subcontractors regarding their status as a small business concern, a small business concern owned and controlled by socially and economically disadvantaged individuals or a small business concern owned and controlled by women.

(End of clause)

20 52.219-9 I SMALL, SMALL DISADVANTAGED AND WOMEN-OWNED SMALL BUSINESS  
SUBCONTRACTING PLAN (AUG 1996)--ALTERNATE I (OCT 1995)

(a) This clause does not apply to small business concerns.

(b) "Commercial product," as used in this clause, means a product in regular production that is sold in substantial quantities to the general public and/or industry at established catalog or market prices. It also means a product which, in the opinion of the Contracting Officer, differs only insignificantly from the Contractor's commercial product.

"Subcontract," as used in this clause, means any agreement (other than one involving an employer-employee relationship) entered into by a Federal Government prime Contractor or subcontractor calling for supplies or services required for performance of the contract or subcontract.

(c) The apparent low bidder, upon request by the Contracting Officer,

shall submit a subcontracting plan, where applicable, which separately addresses subcontracting with small business concerns, with small disadvantaged business concerns and with women-owned small business concerns. If the bidder is submitting an individual contract plan, the plan must separately address subcontracting with small business concerns, small disadvantaged business concerns and women-owned small business concerns, with a separate part for the basic contract and separate parts for each option (if any). The plan shall be included in and made a part of the resultant contract. The subcontracting plan shall be submitted within the time specified by the Contracting Officer. Failure to submit the subcontracting plan shall make the bidder ineligible for the award of a contract.

(d) The offeror's subcontracting plan shall include the following:

(1) Goals, expressed in terms of percentages of total planned subcontracting dollars, for the use of small business concerns, small disadvantaged business concerns and women-owned small business concerns as subcontractors. The offeror shall include all subcontracts that contribute to contract performance, and may include a proportionate share of products and services that are normally allocated as indirect costs.

(2) A statement of--

(i) Total dollars planned to be subcontracted;

(ii) Total dollars planned to be subcontracted to small business concerns;

(iii) Total dollars planned to be subcontracted to small disadvantaged business concerns; and

(iv) Total dollars planned to be subcontracted to women-owned small business concerns.

(3) A description of the principal types of supplies and services to be subcontracted, and an identification of the types planned for subcontracting to (i) small business concerns, (ii) small disadvantaged business concerns and (iii) women-owned small business concerns.

(4) A description of the method used to develop the subcontracting goals in paragraph (d)(1) of this clause.

(5) A description of the method used to identify potential sources for solicitation purposes (e.g., existing company source lists, the Procurement Automated Source System (PASS) of the Small Business Administration, the National Minority Purchasing Council Vendor Information Service, the Research and Information Division of the Minority Business Development Agency in the Department of Commerce, or small, small disadvantaged and women-owned small business concerns trade associations). A firm may rely on the information contained in PASS as an accurate representation of a concern's size and ownership characteristics for purposes of maintaining a small business source list. A firm may rely on PASS as its small business source list. Use of the PASS as its source list does not relieve a firm of its responsibilities (e.g., outreach, assistance, counseling, publicizing subcontracting opportunities) in this clause.

(6) A statement as to whether or not the offeror included indirect costs in establishing subcontracting goals, and a description of the method used to determine the proportionate share of indirect costs to be incurred with (i) small business concerns, (ii) small disadvantaged business concerns, and (iii) women-owned small business concerns.

(7) The name of the individual employed by the offeror who will administer the offeror's subcontracting program, and a description of the duties of the individual.

(8) A description of the efforts the offeror will make to assure that small, small disadvantaged and women-owned small business concerns have an equitable opportunity to compete for subcontracts.

(9) Assurances that the offeror will include the clause in this contract entitled "Utilization of Small, Small Disadvantaged and Women-Owned Small Business Concerns" in all subcontracts that offer further subcontracting opportunities, and that the offeror will require all subcontractors (except small business concerns) who receive subcontracts in excess of \$500,000 (\$1,000,000 for construction of any public facility) to adopt a plan similar to the plan agreed to by the offeror.

(10) Assurances that the offeror will (i) cooperate in any studies or surveys as may be required, (ii) submit periodic reports in order to allow the Government to determine the extent of compliance by the offeror with the subcontracting plan, (iii) submit Standard Form (SF) 294, Subcontracting Report for Individual Contracts, and/or SF 295, Summary Subcontract Report, in accordance with the instructions on the forms, and (iv) ensure that its subcontractors agree to submit Standard Forms 294 and 295.

(11) A recitation of the types of records the offeror will maintain to demonstrate procedures that have been adopted to comply with the requirements and goals in the plan, including establishing source lists; and a description of its efforts to locate small, small disadvantaged and women-owned small business concerns and award subcontracts to them. The records shall include at least the following (on a plant-wide or company-wide basis, unless otherwise indicated):

(i) Source lists (e.g., PASS), guides, and other data that identify small, small disadvantaged and women-owned small business concerns.

(ii) Organizations contacted in an attempt to locate sources that are small, small disadvantaged or women-owned small business concerns.

(iii) Records on each subcontract solicitation resulting in an award of more than \$100,000, indicating (A) whether small business concerns were solicited and if not, why not, (B) whether small disadvantaged business concerns were solicited and if not, why not, (C) whether women-owned small business concerns were solicited and if not, why not, and (D) if applicable, the reason award was not made to a small business concern.

(iv) Records of any outreach efforts to contact (A) trade associations, (B) business development organizations, and (C) conferences and trade fairs to locate small, small disadvantaged and women-owned small business sources.

(v) Records of internal guidance and encouragement provided to buyers through (A) workshops, seminars, training, etc., and (B) monitoring performance to evaluate compliance with the program's requirements.

(vi) On a contract-by-contract basis, records to support award data submitted by the offeror to the Government, including the name, address, and business size of each subcontractor. Contractors having company or division-wide annual plans need not comply with this requirement.



(e) In order to effectively implement this plan to the extent consistent with efficient contract performance, the Contractor shall perform the following functions:

(1) Assist small, small disadvantaged and women-owned small business concerns by arranging solicitations, time for the preparation of bids, quantities, specifications, and delivery schedules so as to facilitate the participation by such concerns. Where the contractor's lists of potential small, small disadvantaged and women-owned small business subcontractors are excessively long, reasonable effort shall be made to give all such small business concerns an opportunity to compete over a period of time.

(2) Provide adequate and timely consideration of the potentialities of small, small disadvantaged and women-owned small business concerns in all "make-or-buy" decisions.

(3) Counsel and discuss subcontracting opportunities with representatives of small, small disadvantaged and women-owned small business firms.

(4) Provide notice to subcontractors concerning penalties and remedies for misrepresentations of business status as small, small disadvantaged or women-owned small business for the purpose of obtaining a subcontract that is to be included as part or all of a goal contained in the Contractor's subcontracting plan.

(f) A master subcontracting plan on a plant or division-wide basis which contains all the elements required by (d) above, except goals, may be incorporated by reference as a part of the subcontracting plan required of the offeror by this clause; provided, (1) the master plan has been approved, (2) the offeror provides copies of the approved master plan and evidence of its approval to the Contracting Officer, and (3) goals and any deviations from the master plan deemed necessary by the Contracting Officer to satisfy the requirements of this contract are set forth in the individual subcontracting plan.

(g)(1) If a commercial product is offered, the subcontracting plan required by this clause may relate to the offeror's production generally, for both commercial and noncommercial products, rather than solely to the Government contract. In these cases, the offeror shall, with the concurrence of the Contracting Officer, submit one company-wide or division-wide annual plan.

(2) The annual plan shall be reviewed for approval by the agency awarding the offeror its first prime contract requiring a subcontracting plan during the fiscal year, or by an agency satisfactory to the Contracting Officer.

(3) The approved plan shall remain in effect during the offeror's fiscal year for all of the offeror's commercial products.

(h) Prior compliance of the offeror with other such subcontracting plans under previous contracts will be considered by the Contracting Officer in determining the responsibility of the offeror for award of the contract.

(i) The failure of the Contractor or subcontractor to comply in good faith with (1) the clause of this contract entitled "Utilization Of Small, Small Disadvantaged and Women-Owned Small Business Concerns," or (2) an approved plan required by this clause, shall be a material breach of the contract.

(End of clause)

(a) "Failure to make a good faith effort to comply with the subcontracting plan," as used in this clause, means a willful or intentional failure to perform in accordance with the requirements of the subcontracting plan approved under the clause in this contract entitled "Small, Small Disadvantaged and Women-Owned Small Business Subcontracting Plan," or willful or intentional action to frustrate the plan.

(b) Performance shall be measured by applying the percentage goals to the total actual subcontracting dollars or, if a commercial plan is involved, to the pro rata share of actual subcontracting dollars attributable to Government contracts covered by the commercial plan. If, at contract completion or, in the case of a commercial plan, at the close of the fiscal year for which the plan is applicable, the Contractor has failed to meet its subcontracting goals and the Contracting Officer decides in accordance with paragraph (c) of this clause that the Contractor failed to make a good faith effort to comply with its subcontracting plan, established in accordance with the clause in this contract entitled "Small, Small Disadvantaged and Women-Owned Small Business Subcontracting Plan," the Contractor shall pay the Government liquidated damages in an amount stated. The amount of probable damages attributable to the Contractor's failure to comply shall be an amount equal to the actual dollar amount by which the Contractor failed to achieve each subcontract goal.

(c) Before the Contracting Officer makes a final decision that the Contractor has failed to make such good faith effort, the Contracting Officer shall give the Contractor written notice specifying the failure and permitting the Contractor to demonstrate what good faith efforts have been made and to discuss the matter. Failure to respond to the notice may be taken as an admission that no valid explanation exists. If, after consideration of all the pertinent data, the Contracting Officer finds that the Contractor failed to make a good faith effort to comply with the subcontracting plan, the Contracting Officer shall issue a final decision to that effect and require that the Contractor pay the Government liquidated damages as provided in paragraph (b) of this clause.

(d) With respect to commercial plans, the Contracting Officer who approved the plan will perform the functions of the Contracting Officer under this clause on behalf of all agencies with contracts covered by the commercial plan.

(e) The Contractor shall have the right of appeal, under the clause in this contract entitled, Disputes, from any final decision of the Contracting Officer.

(f) Liquidated damages shall be in addition to any other remedies that the Government may have.

(End of clause)

(a) Definitions. As used in this clause--

Small disadvantaged business concern means an offeror that represents, as part of its offer, that it is a small business under the size standard applicable to this acquisition; and either--

(1) It has received certification by the Small Business Administration as a small disadvantaged business concern consistent with 13 CFR 124, Subpart B; and

(i) No material change in disadvantaged ownership and control has occurred since its certification;

(ii) Where the concern is owned by one or more disadvantaged individuals, the net worth of each individual upon whom the certification is based does not exceed \$750,000 after taking into account the applicable exclusions set forth at 13 CFR 124.104

(c)(2); and

(iii) It is listed, on the date of its representation, on the register of small disadvantaged business concerns maintained by the Small Business Administration;

(2) It has submitted a completed application to the Small Business Administration or a Private Certifier to be certified as a small disadvantaged business concern in accordance with 13 CFR 124, Subpart B, and a decision on that application is pending, and that no material change in disadvantaged ownership and control has occurred since its application was submitted. In this case, in order to receive the benefit of a price evaluation adjustment, an offeror must receive certification as a small disadvantaged business concern by the Small Business Administration prior to contract award; or

(3) Is a joint venture as defined in 13 CFR 124.1002(f).

Historically black college or university means an institution determined by the Secretary of Education to meet the requirements of 34 CFR 608.2. For the Department of Defense (DoD), the National Aeronautics and Space Administration (NASA), and the Coast Guard, the term also includes any nonprofit research institution that was an integral part of such a college or university before November 14, 1986.

Minority institution means an institution of higher education meeting the requirements of Section 1046(3) of the Higher Education Act of 1965 (20 U.S.C. 1135d-5(3)) which, for purposes of this clause, includes a Hispanic-serving institution of higher education as defined in Section 316(b)(1) of the Act (20 U.S.C. 1059c(b)(1)).

United States means the United States, its territories and possessions, the Commonwealth of Puerto Rico, the U.S. Trust Territory of the Pacific Islands, and the District of Columbia.

(b) Evaluation adjustment. (1) Offers will be evaluated by adding a factor of ten (10%) percent to the price of all offers, except--

(i) Offers from small disadvantaged business concerns, that have not waived the adjustment, whose address is in a region for which an evaluation adjustment is authorized;

(ii) For DOD, NASA, and Coast Guard acquisitions, otherwise successful offers from historically black colleges or universities

or minority institutions;

(iii) Otherwise successful offers of eligible products under the Trade Agreements Act when the dollar threshold for application of the Act is equaled or exceeded (see section 25.402 of the Federal Acquisition Regulation (FAR));

(iv) Otherwise successful offers where application of the factor would be inconsistent with a Memorandum of Understanding or other international agreement with a foreign government; and

(v) For DOD acquisitions, otherwise successful offers of qualifying country end products (see sections 225.000-70 and 252.225-7001 of the Defense FAR Supplement).

(2) The factor shall be applied on a line item basis or to any group of items on which award may be made. Other evaluation factors described in the solicitation shall be applied before application of the factor. The factor may not be applied if using the adjustment would cause the contract award to be made at a price that exceeds the fair market price by more than the factor in paragraph (b)(1) of this clause.

(c) Waiver of evaluation adjustment. A small disadvantaged business concern may elect to waive the adjustment, in which case the factor will be added to its offer for evaluation purposes. The agreements in paragraph (d) of this clause do not apply to offers that waive the adjustment.

\_\_\_\_\_ Offeror elects to waive the adjustment.

(d) Agreements. (1) A small disadvantaged business concern, that did not waive the adjustment, agrees that in performance of the contract, in the case of a contract for--

(i) Services, except construction, at least 50 percent of the cost of personnel for contract performance will be spent for employees of the concern;

(ii) Supplies (other than procurement from a nonmanufacturer of such supplies), at least 50 percent of the cost of manufacturing, excluding the cost of materials, will be performed by the concern;

(iii) General construction, at least 15 percent of the cost of the contract, excluding the cost of materials, will be performed by employees of the concern; or

(iv) Construction by special trade contractors, at least 25 percent of the cost of the contract, excluding the cost of materials, will be performed by employees of the concern.

(2) A small disadvantaged business concern submitting an offer in its own name agrees to furnish in performing this contract only end items manufactured or produced by small disadvantaged business concerns in the United States. This paragraph does not apply in connection with construction or service contracts.

(End of clause)

23 52.222-3 CONVICT LABOR (AUG 1996)

The Contractor agrees not to employ in the performance of this contract any person undergoing a sentence of imprisonment which has been imposed by any court of a State, the District of Columbia, the Commonwealth of Puerto



individual was required or permitted to work in excess of the standard workweek of 40 hours without payment of the overtime wages required by provisions set forth in paragraph (a) of this clause.

(c) Withholding for unpaid wages and liquidated damages. The Contracting Officer shall upon his or her own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld, from any moneys payable on account of work performed by the Contractor or subcontractor under any such contract or any other Federal contract with the same Prime Contractor, or any other Federally-assisted contract subject to the Contract Work Hours and Safety Standards Act which is held by the same Prime Contractor, such sums as may be determined to be necessary to satisfy any liabilities of such Contractor or subcontractor for unpaid wages and liquidated damages as provided in the provisions set forth in paragraph (b) of this clause.

(d) Payrolls and basic records. (1) The Contractor or subcontractor shall maintain payrolls and basic payroll records during the course of contract work and shall preserve them for a period of 3 years from the completion of the contract for all laborers and mechanics working on the contract. Such records shall contain the name and address of each such employee, social security number, correct classifications, hourly rates of wages paid, daily and weekly number of hours worked, deductions made, and actual wages paid. Nothing in this paragraph shall require the duplication of records required to be maintained for construction work by Department of Labor regulations at 29 CFR 5.5(a)(3) implementing the Davis-Bacon Act.

(2) The records to be maintained under paragraph (d)(1) of this clause shall be made available by the Contractor or subcontractor for inspection, copying, or transcription by authorized representatives of the Contracting Officer or the Department of Labor. The Contractor or subcontractor shall permit such representatives to interview employees during working hours on the job.

(e) Subcontracts. The Contractor or subcontractor shall insert in any subcontracts exceeding \$100,000, the provisions set forth in paragraphs (a) through (e) of this clause and also a clause requiring the subcontractors to include these provisions in any lower tier subcontracts. The Prime Contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with the provisions set forth in paragraphs (a) through (e) of this clause.

(End of clause)

25 52. 222- 6 DAVIS- BACON ACT (FEB 1995)

(a) All laborers and mechanics employed or working upon the site of the work will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by regulations issued by the Secretary of Labor under the Copeland Act (29 CFR Part 3)), the full amount of wages and bona fide fringe benefits (or cash equivalents thereof) due at time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the Contractor and such laborers and mechanics. Contributions made

or costs reasonably anticipated for bona fide fringe benefits under section 1(b)(2) of the Davis-Bacon Act on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of paragraph (d) of this clause; also, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs which cover the particular weekly period, are deemed to be constructively made or incurred during such period. Such laborers and mechanics shall be paid not less than the appropriate wage rate and fringe benefits in the wage determination for the classification of work actually performed, without regard to skill, except as provided in the clause entitled Apprentices and Trainees. Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein; provided, that the employer's payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination (including any additional classifications and wage rates conformed under paragraph (b) of this clause) and the Davis-Bacon poster (WH-1321) shall be posted at all times by the Contractor and its subcontractors at the site of the work in a prominent and accessible place where it can be easily seen by the workers.

(b)(1) The Contracting Officer shall require that any class of laborers or mechanics which is not listed in the wage determination and which is to be employed under the contract shall be classified in conformance with the wage determination. The Contracting Officer shall approve an additional classification and wage rate and fringe benefits therefor only when all the following criteria have been met:

(i) The work to be performed by the classification requested is not performed by a classification in the wage determination.

(ii) The classification is utilized in the area by the construction industry.

(iii) The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination.

(iv) With respect to helpers, such a classification prevails in the area in which the work is performed.

(2) If the Contractor and the laborers and mechanics to be employed in the classification (if known), or their representatives, and the Contracting Officer agree on the classification and wage rate (including the amount designated for fringe benefits, where appropriate), a report of the action taken shall be sent by the Contracting Officer to the Administrator of the Wage and Hour Division, Employment Standards Administration, U.S. Department of Labor, Washington, DC 20210. The Administrator or an authorized representative will approve, modify, or disapprove every additional classification action within 30 days of receipt and so advise the Contracting Officer or will notify the Contracting Officer within the 30-day period that additional time is necessary.

(3) In the event the Contractor, the laborers or mechanics to be employed in the classification, or their representatives, and the Contracting Officer do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), the Contracting Officer shall refer the questions,

including the views of all interested parties and the recommendation of the Contracting Officer, to the Administrator of the Wage and Hour Division for determination. The Administrator, or an authorized representative, will issue a determination within 30 days of receipt and so advise the Contracting Officer or will notify the Contracting Officer within the 30-day period that additional time is necessary.

(4) The wage rate (including fringe benefits, where appropriate) determined pursuant to subparagraphs (b)(2) and (b)(3) of this clause shall be paid to all workers performing work in the classification under this contract from the first day on which work is performed in the classification.

(c) Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the Contractor shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.

(d) If the Contractor does not make payments to a trustee or other third person, the Contractor may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program; provided, that the Secretary of Labor has found, upon the written request of the Contractor, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the Contractor to set aside in a separate account assets for the meeting of obligations under the plan or program.

(End of clause)

26    52. 222- 7            WITHHOLDING OF FUNDS (FEB 1988)

The Contracting Officer shall, upon his or her own action or upon written request of an authorized representative of the Department of Labor, withhold or cause to be withheld from the Contractor under this contract or any other Federal contract with the same Prime Contractor, or any other Federally assisted contract subject to Davis-Bacon prevailing wage requirements, which is held by the same Prime Contractor, so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices, trainees, and helpers, employed by the Contractor or any subcontractor the full amount of wages required by the contract. In the event of failure to pay any laborer or mechanic, including any apprentice, trainee, or helper, employed or working on the site of the work, all or part of the wages required by the contract, the Contracting Officer may, after written notice to the Contractor, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased.

(End of clause)

27    52. 222- 8            PAYROLLS AND BASIC RECORDS (FEB 1988)

(a) Payrolls and basic records relating thereto shall be maintained by the Contractor during the course of the work and preserved for a period of 3 years thereafter for all laborers and mechanics working at the site of



the work. Such records shall contain the name, address, and social security number of each such worker, his or her correct classification, hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in section 1(b)(2)(B) of the Davis-Bacon Act), daily and weekly number of hours worked, deductions made, and actual wages paid. Whenever the Secretary of Labor has found, under paragraph (d) of the clause entitled Davis-Bacon Act, that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in section 1(b)(2)(B) of the Davis-Bacon Act, the Contractor shall maintain records which show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and records which show the costs anticipated or the actual cost incurred in providing such benefits. Contractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprenticeship programs and certification of trainee programs, the registration of apprentices and trainees, and the ratios and wage rates prescribed in the applicable programs.

(b)(1) The Contractor shall submit weekly for each week in which any contract work is performed a copy of all payrolls to the Contracting Officer. The payrolls submitted shall set out accurately and completely all of the information required to be maintained under paragraph (a) of this clause. This information may be submitted in any form desired. Optional Form WH-347 (Federal Stock Number 029-005-00014-1) is available for this purpose and may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. The Prime Contractor is responsible for the submission of copies of payrolls by all subcontractors.

(2) Each payroll submitted shall be accompanied by a "Statement of Compliance," signed by the Contractor or subcontractor or his or her agent who pays or supervises the payment of the persons employed under the contract and shall certify--

(i) That the payroll for the payroll period contains the information required to be maintained under paragraph (a) of this clause and that such information is correct and complete;

(ii) That each laborer or mechanic (including each helper, apprentice, and trainee) employed on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in the Regulations, 29 CFR Part 3; and

(iii) That each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification of work performed, as specified in the applicable wage determination incorporated into the contract.

(3) The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH-347 shall satisfy the requirement for submission of the "Statement of Compliance" required by subparagraph (b)(2) of this clause.

(4) The falsification of any of the certifications in this clause may subject the Contractor or subcontractor to civil or criminal prosecution under Section 1001 of Title 18 and Section 3729 of Title 31 of the United States Code.

(c) The Contractor or subcontractor shall make the records required under paragraph (a) of this clause available for inspection, copying, or transcription by the Contracting Officer or authorized representatives of the Contracting Officer or the Department of Labor. The Contractor or subcontractor shall permit the Contracting Officer or representatives of the Contracting Officer or the Department of Labor to interview employees during working hours on the job. If the Contractor or subcontractor fails to submit required records or to make them available, the Contracting Officer may, after written notice to the Contractor, take such action as may be necessary to cause the suspension of any further payment. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 CFR 5.12.

(End of clause)

28     52.222-9     APPRENTICES AND TRAINEES (FEB 1988)

(a) Apprentices. Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U. S. Department of Labor, Employment and Training Administration, Bureau of Apprenticeship and Training, or with a State Apprenticeship Agency recognized by the Bureau, or if a person is employed in his or her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Bureau of Apprenticeship and Training or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice. The allowable ratio of apprentices to journeymen on the job site in any craft classification shall not be greater than the ratio permitted to the Contractor as to the entire work force under the registered program. Any worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated in this paragraph, shall be paid not less than the applicable wage determination for the classification of work actually performed. In addition, any apprentice performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a contractor is performing construction on a project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyman's hourly rate) specified in the Contractor's or subcontractor's registered program shall be observed. Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not

specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination. In the event the Bureau of Apprenticeship and Training, or a State Apprenticeship Agency recognized by the Bureau, withdraws approval of an apprenticeship program, the Contractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(b) Trainees. Except as provided in 29 CFR 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration. The ratio of trainees to journeymen on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration. Every trainee must be paid at not less than the rate specified in the approved program for the trainee's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed in the wage determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman wage rate in the wage determination which provides for less than full fringe benefits for apprentices. Any employee listed on the payroll at a trainee rate who is not registered and participating in a training plan approved by the Employment and Training Administration shall be paid not less than the applicable wage rate in the wage determination for the classification of work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate in the wage determination for the work actually performed. In the event the Employment and Training Administration withdraws approval of a training program, the Contractor will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(c) Equal employment opportunity. The utilization of apprentices, trainees, and journeymen under this clause shall be in conformity with the equal employment opportunity requirements of Executive Order 11246, as amended, and 29 CFR Part 30.

(End of clause)

29 52.222-10 COMPLIANCE WITH COPELAND ACT REQUIREMENTS (FEB 1988)

The Contractor shall comply with the requirements of 29 CFR Part 3, which are hereby incorporated by reference in this contract.

(End of clause)

30 52. 222- 11 SUBCONTRACTS (LABOR STANDARDS) (FEB 1988)

(a) The Contractor or subcontractor shall insert in any subcontracts the clauses entitled Davis-Bacon Act, Contract Work Hours and Safety Standards Act--Overtime Compensation, Apprentices and Trainees, Payrolls and Basic Records, Compliance with Copeland Act Requirements, Withholding of Funds, Subcontracts (Labor Standards), Contract Termination--Debarment, Disputes Concerning Labor Standards, Compliance with Davis-Bacon and Related Act Regulations, and Certification of Eligibility, and such other clauses as the Contracting Officer may, by appropriate instructions, require, and also a clause requiring subcontractors to include these clauses in any lower tier subcontracts. The Prime Contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with all the contract clauses cited in this paragraph.

(b)(1) Within 14 days after award of the contract, the Contractor shall deliver to the Contracting Officer a completed Statement and Acknowledgment Form (SF 1413) for each subcontract, including the subcontractor's signed and dated acknowledgment that the clauses set forth in paragraph (a) of this clause have been included in the subcontract.

(2) Within 14 days after the award of any subsequently awarded subcontract the Contractor shall deliver to the Contracting Officer an updated completed SF 1413 for such additional subcontract.

(End of clause)

31 52. 222- 12 CONTRACT TERMINATION--DEBARMENT (FEB 1988)

A breach of the contract clauses entitled Davis-Bacon Act, Contract Work Hours and Safety Standards Act--Overtime Compensation, Apprentices and Trainees, Payrolls and Basic Records, Compliance with Copeland Act Requirements, Subcontracts (Labor Standards), Compliance with Davis-Bacon and Related Act Regulations, or Certification of Eligibility may be grounds for termination of the contract, and for debarment as a Contractor and subcontractor as provided in 29 CFR 5. 12.

(End of clause)

32 52. 222- 13 COMPLIANCE WITH DAVIS-BACON AND RELATED ACT REGULATIONS (FEB 1988)

All rulings and interpretations of the Davis-Bacon and Related Acts contained in 29 CFR Parts 1, 3, and 5 are hereby incorporated by reference in this contract.

(End of clause)

33 52. 222- 14 DISPUTES CONCERNING LABOR STANDARDS (FEB 1988)

The United States Department of Labor has set forth in 29 CFR Parts 5, 6, and 7 procedures for resolving disputes concerning labor standards requirements. Such disputes shall be resolved in accordance with those procedures and not the Disputes clause of this contract. Disputes within

the meaning of this clause include disputes between the Contractor (or any of its subcontractors) and the contracting agency, the U. S. Department of Labor, or the employees of their representatives.

(End of clause)

34 52. 222- 15 CERTIFICATION OF ELIGIBILITY (FEB 1988)

(a) By entering into this contract, the Contractor certifies that neither it (nor he or she) nor any person or firm who has an interest in the Contractor's firm is a person or firm ineligible to be awarded Government contracts by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5. 12(a) (1).

(b) No part of this contract shall be subcontracted to any person or firm ineligible for award of a Government contract by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5. 12(a) (1).

(c) The penalty for making false statements is prescribed in the U. S. Criminal Code, 18 U. S. C. 1001.

(End of clause)

35 52. 222- 26 D EQUAL OPPORTUNITY (APR 1984) (DEVIATION)

(a) If, during any 12-month period (including the 12 months preceding the award of this contract), the Contractor has been or is awarded nonexempt Federal contracts and/or subcontracts that have an aggregate value in excess of \$10,000, the Contractor shall comply with subparagraphs (b)(1) through (11) below. Upon request, the Contractor shall provide information necessary to determine the applicability of this clause.

(b) During performing this contract, the Contractor agrees as follows:

(1) The Contractor shall not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin. Note: It shall not be a violation of E. O. 11246 for a contractor to extend a publicly announced preference in employment to Indians living on or near an Indian reservation in connection with employment opportunities on or near an Indian reservation. See 22. 807(b) (4).

(2) The Contractor shall take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, color, religion, sex, or national origin. This shall include, but not be limited to, (i) employment, (ii) upgrading, (iii) demotion, (iv) transfer, (v) recruitment or recruitment advertising, (vi) layoff or termination, (vii) rates of pay or other forms of compensation, and (viii) selection for training, including apprenticeship.

(3) The Contractor shall post in conspicuous places available to employees and applicants for employment the notices to be provided by the Contracting Officer that explain this clause.

(4) The Contractor shall, in all solicitations or advertisements for employees placed by or on behalf of the Contractor, state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex, or national origin.

(5) The Contractor shall send, to each labor union or representative of workers with which it has a collective bargaining agreement or other contract or understanding, the notice to be provided by the Contracting Officer advising the labor union or workers' representative of the Contractor's commitments under this clause, and post copies of the notice in conspicuous places available to employees and applicants for employment.

(6) The Contractor shall comply with Executive Order 11246, as amended, and the rules, regulations, and orders of the Secretary of Labor.

(7) The Contractor shall furnish to the contracting agency all information required by Executive Order 11246, as amended, and by the rules, regulations, and orders of the Secretary of Labor. The Contractor shall, within 30 days following the award, file Standard Form 100 (EO-1), or any successor form, unless filed within 12 months preceding the date of award.

(8) The Contractor shall permit access to its premises by the contracting officer or the Office of Federal Contract Compliance Programs (OFCCP) for the purpose of conducting on-site compliance reviews and inspecting such books, records, accounts, and other materials as may be relevant to an investigation to ascertain the Contractor's compliance with the applicable rules, regulations, and orders.

(9) If the OFCCP determines that the Contractor is not in compliance with this clause or any rule, regulation, or order of the Secretary of Labor, this contract may be canceled, terminated, or suspended in whole or in part and the Contractor may be declared ineligible for further Government contracts, under the procedures authorized in Executive Order 11246, as amended. In addition, sanctions may be imposed and remedies invoked against the Contractor as provided in Executive Order 11246, as amended; in the rules, regulations, and orders of the Secretary of Labor; or as otherwise provided by law.

(10) The Contractor shall include the terms and conditions of subparagraph (b)(1) through (11) of this clause in every subcontract or purchase order that is not exempted by the rules, regulations, or orders of the Secretary of Labor issued under Executive Order 11246, as amended, so that these terms and conditions will be binding upon each subcontractor or vendor.

(11) The Contractor shall take such action with respect to any subcontract or purchase order as the contracting officer may direct as a means of enforcing these terms and conditions, including sanctions for noncompliance; provided, that if the Contractor becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of any direction, the Contractor may request the United States to enter into the litigation to protect the interests of the United States.

(c) Notwithstanding any other clause in this contract, disputes relative to this clause will be governed by the procedures in 41 CFR 60-1.1.  
(End of clause)

36 52.222-27 D AFFIRMATIVE ACTION COMPLIANCE REQUIREMENTS FOR CONSTRUCTION  
(APR 1984) (DEVIATION)

(a) Definitions.

"Covered area," as used in this clause, means the geographical area described in the solicitation for this contract.

"Deputy Assistant Secretary," as used in this clause, means the Deputy Assistant Secretary for Federal Contract Compliance Programs, United States Department of Labor or a designee.

"Employer's identification number," as used in this clause, means the Federal Social Security number used on the employer's quarterly federal tax return, U. S. Treasury Department Form 941.

"Minority," as used in this clause, means--

(1) American Indian or Alaskan Native (all persons having origins in any of the original peoples of North America and maintaining identifiable tribal affiliations through membership and participation or community identification).

(2) Asian and Pacific Islander (all persons having origins in any of the original peoples of the Far East, Southeast Asia, the Indian Subcontinent, or the Pacific Islands);

(3) Black (all persons having origins in any of the black African racial groups not of Hispanic origin); and

(4) Hispanic (all persons of Mexican, Puerto Rican, Cuban, Central or South American, or other Spanish culture or origin, regardless of race).

(b) If the Contractor, or a subcontractor at any tier, subcontracts a portion of the work involving any construction trade, each such subcontract in excess of \$10,000 shall include this clause and the Notice containing the goals for minority and female participation stated in the solicitation for this contract.

(c) If the Contractor is participating in a Hometown Plan (41 CFR 60-4) approved by the U. S. Department of Labor in a covered area, either individually or through an association, its affirmative action obligations on all work in the plan area (including goals) shall comply with the plan for those trades that have unions participating in the plan. Contractors must be able to demonstrate participation in, and compliance with, the provisions of the plan. Each Contractor or subcontractor participating in an approved plan is also required to comply with its obligations under the Equal Opportunity clause, and to make a good faith effort to achieve each goal under the plan in each trade in which it has employees. The overall good-faith performance by other Contractors or subcontractors toward a goal in an approved plan does not excuse any Contractor's or subcontractor's failure to make good-faith efforts to achieve the plan's goals.

(d) The Contractor shall implement the affirmative action procedures in subparagraphs (g)(1) through (16) of this clause. The goals stated in the solicitation for this contract are expressed as percentages of the total

hours of employment and training of minority and female utilization that the Contractor should reasonably be able to achieve in each construction trade in which it has employees in the covered area. If the Contractor performs construction work in a geographical area located outside of the covered area, it shall apply the goals established for the geographical area where that work is actually performed. The Contractor is expected to make substantially uniform progress toward its goals in each craft.

(e) Neither the terms and conditions of any collective bargaining agreement, nor the failure by a union with which the Contractor has a collective bargaining agreement, to refer minorities or women shall excuse the Contractor's obligations under this clause, Executive Order 11246, as amended, or the regulations thereunder.

(f) In order for the nonworking training hours of apprentices and trainees to be counted in meeting the goals, apprentices and trainees must be employed by the Contractor during the training period, and the Contractor must have made a commitment to employ the apprentices and trainees at the completion of their training, subject to the availability of employment opportunities. Trainees must be trained pursuant to training programs approved by the U. S. Department of Labor.

(g) The Contractor shall take affirmative action to ensure equal employment opportunity. The evaluation of the Contractor's compliance with this clause shall be based upon its effort to achieve maximum results from its actions. The Contractor shall document these efforts fully and implement affirmative action steps at least as extensive as the following:

(1) Ensure a working environment free of harassment, intimidation, and coercion at all sites and in all facilities where the Contractor's employees are assigned to work. The Contractor, if possible, will assign two or more women to each construction project. The Contractor shall ensure that foremen, superintendents, and other onsite supervisory personnel are aware of and carry out the Contractor's obligation to maintain such a working environment, with specific attention to minority or female individuals working at these sites or facilities.

(2) Establish and maintain a current list of sources for minority and female recruitment. Provide written notification to minority and female recruitment sources and community organizations when the Contractor or its unions have employment opportunities available, and maintain a record of the organizations' responses.

(3) Establish and maintain a current file of the names, addresses, and telephone numbers of each minority and female off-the-street applicant, referrals of minorities or females from unions, recruitment sources, or community organizations, and the action taken with respect to each individual. If an individual was sent to the union hiring hall for referral and not referred back to the Contractor by the union or, if referred back, not employed by the Contractor, this shall be documented in the file, along with whatever additional actions the Contractor may have taken.

(4) Immediately notify the Deputy Assistant Secretary when the union or unions with which the Contractor has a collective bargaining agreement has not referred back to the Contractor a minority or woman sent by the Contractor, or when the Contractor has other information that the union referral process has impeded the Contractor's efforts to meet its obligations.



(5) Develop on-the-job training opportunities and/or participate in training programs for the area that expressly include minorities and women, including upgrading programs and apprenticeship and trainee programs relevant to the Contractor's employment needs, especially those programs funded or approved by the Department of Labor. The Contractor shall provide notice of these programs to the sources compiled under subparagraph (g)(2) above.

(6) Disseminate the Contractor's equal employment policy by--

(i) Providing notice of the policy to unions and to training, recruitment, and outreach programs, and requesting their cooperation in assisting the Contractor in meeting its contract obligations;

(ii) Including the policy in any policy manual and in collective bargaining agreements;

(iii) Publicizing the policy in the company newspaper, annual report, etc.;

(iv) Reviewing the policy with all management personnel and with all minority and female employees at least once a year; and

(v) Posting the policy on bulletin boards accessible to employees at each location where construction work is performed.

(7) Review, at least annually, the Contractor's equal employment policy and affirmative action obligations with all employees having responsibility for hiring, assignment, layoff, termination, or other employment decisions. Conduct review of this policy with all onsite supervisory personnel before initiating construction work at a job site. A written record shall be made and maintained identifying the time and place of these meetings, persons attending, subject matter discussed, and disposition of the subject matter.

(8) Disseminate the Contractor's equal employment policy externally by including it in any advertising in the news media, specifically including minority and female news media. Provide written notification to, and discuss this policy with, other Contractors and subcontractors with which the Contractor does or anticipates doing business.

(9) Direct recruitment efforts, both oral and written, to minority, female, and community organizations, to schools with minority and female students, and to minority and female recruitment and training organizations serving the Contractor's recruitment area and employment needs. Not later than 1 month before the date for acceptance of applications for apprenticeship or training by any recruitment source, send written notification to organizations such as the above, describing the openings, screening procedures, and tests to be used in the selection process.

(10) Encourage present minority and female employees to recruit minority persons and women. Where reasonable, provide after-school, summer, and vacation employment to minority and female youth both on the site and in other areas of the Contractor's workforce.

(11) Validate all tests and other selection requirements where required under 41 CFR 60-3.

(12) Conduct, at least annually, an inventory and evaluation at least of all minority and female personnel for promotional opportunities. Encourage these employees to seek or to prepare for, through appropriate training, etc., opportunities for promotion.

(13) Ensure that seniority practices job classifications, work assignments, and other personnel practices do not have a discriminatory effect by continually monitoring all personnel and employment-related activities to ensure that the Contractor's obligations under this contract are being carried out.

(14) Ensure that all facilities and company activities are nonsegregated except that separate or single-user rest rooms and necessary dressing or sleeping areas shall be provided to assure privacy between the sexes.

(15) Maintain a record of solicitations for subcontracts for minority and female construction contractors and suppliers, including circulation of solicitations to minority and female contractor associations and other business associations.

(16) Conduct a review, at least annually, of all supervisors' adherence to and performance under the Contractor's equal employment policy and affirmative action obligations.

(h) The Contractor is encouraged to participate in voluntary associations that may assist in fulfilling one or more of the affirmative action obligations contained in subparagraphs (g)(1) through (16). The efforts of a contractor association, joint contractor-union, contractor-community, or similar group of which the contractor is a member and participant may be asserted as fulfilling one or more of its obligations under subparagraphs (g)(1) through (16), provided the Contractor--

(1) Actively participates in the group;

(2) Makes every effort to ensure that the group has a positive impact on the employment of minorities and women in the industry;

(3) Ensures that concrete benefits of the program are reflected in the Contractor's minority and female workforce participation;

(4) Makes a good-faith effort to meet its individual goals and timetables; and

(5) Can provide access to documentation that demonstrates the effectiveness of actions taken on behalf of the Contractor. The obligation to comply is the Contractor's, and failure of such a group to fulfill an obligation shall not be a defense for the Contractor's noncompliance.

(i) A single goal for minorities and a separate single goal for women shall be established. The Contractor is required to provide equal employment opportunity and to take affirmative action for all minority groups, both male and female, and all women, both minority and nonminority. Consequently, the Contractor may be in violation of Executive Order 11246, as amended, if a particular group is employed in a substantially disparate manner.

(j) The Contractor shall not use goals or affirmative action standards to discriminate against any person because of race, color, religion, sex, or national origin.

(k) The Contractor shall not enter into any subcontract with any person or firm debarred from Government contracts under Executive Order 11246, as amended.

(l) The Contractor shall carry out such sanctions and penalties for violation of this clause and of the Equal Opportunity clause, including suspension, termination, and cancellation of existing subcontracts, as may

be imposed or ordered under Executive Order 11246, as amended, and its implementing regulations, by the OFCCP. Any failure to carry out these sanctions and penalties as ordered shall be a violation of this clause and Executive Order 11246, as amended.

(m) The Contractor in fulfilling its obligations under this clause shall implement affirmative action procedures at least as extensive as those prescribed in paragraph (g) above, so as to achieve maximum results from its efforts to ensure equal employment opportunity. If the Contractor fails to comply with the requirements of Executive Order 11246, as amended, the implementing regulations, or this clause, the Deputy Assistant Secretary shall take action as prescribed in 41 CFR 60-4.8.

(n) The Contractor shall designate a responsible official to--

(1) Monitor all employment-related activity to ensure that the Contractor's equal employment policy is being carried out;

(2) Submit reports as may be required by the Government; and

(3) Keep records that shall at least include for each employee the name, address, telephone number, construction trade, union affiliation (if any), employee identification number, social security number, race, sex, status (e.g., mechanic, apprentice, trainee, helper, or laborer), dates of changes in status, hours worked per week in the indicated trade, rate of pay, and locations at which the work was performed. Records shall be maintained in an easily understandable and retrievable form; however, to the degree that existing records satisfy this requirement, separate records are not required to be maintained.

(o) Nothing contained herein shall be construed as a limitation upon the application of other laws that establish different standards of compliance or upon the requirements for the hiring of local or other area residents (e.g., those under the Public Works Employment Act of 1977 and the Community Development Block Grant Program).

(End of clause)

37    52. 222- 35            AFFIRMATIVE ACTION FOR DISABLED VETERANS AND VETERANS OF THE VIETNAM ERA (APR 1998)

(a) Definitions. As used in this clause--

"All employment openings" includes all positions except executive and top management, those positions that will be filled from within the contractor's organization, and positions lasting 3 days or less. This term includes full-time employment, temporary employment of more than 3 days' duration, and part-time employment.

"Appropriate office of the State employment service system" means the local office of the Federal-State national system of public employment offices with assigned responsibility to serve the area where the employment opening is to be filled, including the District of Columbia, Guam, the Commonwealth of Puerto Rico, and the Virgin Islands.

"Positions that will be filled from within the Contractor's organization" means employment openings for which no consideration will be given to persons outside the Contractor's organization (including any affiliates, subsidiaries, and parent companies) and includes any openings that the Contractor proposes to fill from regularly established "recall" lists. The exception does not apply

to a particular opening once an employer decides to consider applicants outside of its organization.

"Veteran of the Vietnam era" means a person who--

(1) Served on active duty for a period of more than 180 days, any part of which occurred between August 5, 1964, and May 7, 1975, and was discharged or released therefrom with other than a dishonorable discharge; or

(2) Was discharged or released from active duty for a service-connected disability if any part of such active duty was performed between August 5, 1964, and May 7, 1975.

(b) General. (1) Regarding any position for which the employee or applicant for employment is qualified, the Contractor shall not discriminate against the individual because the individual is a disabled veteran or a veteran of the Vietnam era. The Contractor agrees to take affirmative action to employ, advance in employment, and otherwise treat qualified disabled veterans and veterans of the Vietnam era without discrimination based upon their disability or veterans' status in all employment practices such as--

(i) Employment;

(ii) Upgrading;

(iii) Demotion or transfer;

(iv) Recruitment;

(v) Advertising;

(vi) Layoff or termination;

(vii) Rates of pay or other forms of compensation; and

(viii) Selection for training, including apprenticeship.

(2) The Contractor agrees to comply with the rules, regulations, and relevant orders of the Secretary of Labor (Secretary) issued under the Vietnam Era Veterans' Readjustment Assistance Act of 1972 (the Act), as amended.

(c) Listing openings. (1) The Contractor agrees to list all employment openings existing at contract award or occurring during contract performance, at an appropriate office of the State employment service system in the locality where the opening occurs. These openings include those occurring at any Contractor facility, including one not connected with performing this contract. An independent corporate affiliate is exempt from this requirement.

(2) State and local government agencies holding Federal contracts of \$10,000 or more shall also list all employment openings with the appropriate office of the State employment service.

(3) The listing of employment openings with the State employment service system is required at least concurrently with using any other recruitment source or effort and involves the obligations of placing a bona fide job order, including accepting referrals of veterans and nonveterans. This listing does not require hiring any particular job applicant or hiring from any particular group of job applicants and is not intended to relieve the Contractor from any requirements of Executive orders or regulations concerning nondiscrimination in employment.

(4) Whenever the Contractor becomes contractually bound to the listing terms of this clause, it shall advise the State employment service system, in each State where it has establishments, of the name

and location of each hiring location in the State. As long as the Contractor is contractually bound to these terms and has so advised the State system, it need not advise the State system of subsequent contracts. The Contractor may advise the State system when it is no longer bound by this contract clause.

(d) Applicability. This clause does not apply to the listing of employment openings that occur and are filled outside the 50 States, the District of Columbia, the Commonwealth of Puerto Rico, Guam, and the Virgin Islands.

(e) Postings. (1) The Contractor agrees to post employment notices stating (i) the Contractor's obligation under the law to take affirmative action to employ and advance in employment qualified disabled veterans and veterans of the Vietnam era, and (ii) the rights of applicants and employees.

(2) These notices shall be posted in conspicuous places that are available to employees and applicants for employment. They shall be in a form prescribed by the Deputy Assistant Secretary for Federal Contract Compliance Programs, Department of Labor (Deputy Assistant Secretary), and provided by or through the Contracting Officer.

(3) The Contractor shall notify each labor union or representative of workers with which it has a collective bargaining agreement or other contract understanding, that the Contractor is bound by the terms of the Act, and is committed to take affirmative action to employ, and advance in employment, qualified disabled veterans and veterans of the Vietnam era.

(f) Noncompliance. If the Contractor does not comply with the requirements of this clause, appropriate actions may be taken under the rules, regulations, and relevant orders of the Secretary issued pursuant to the Act.

(g) Subcontracts. The Contractor shall include the terms of this clause in every subcontract or purchase order of \$10,000 or more unless exempted by rules, regulations, or orders of the Secretary. The Contractor shall act as specified by the Deputy Assistant Secretary to enforce the terms, including action for noncompliance.

(End of clause)

38 52.222-36 AFFIRMATIVE ACTION FOR WORKERS WITH DISABILITIES (JUN 1998)

(a) General. (1) Regarding any position for which the employee or applicant for employment is qualified, the Contractor shall not discriminate against any employee or applicant because of physical or mental disability. The Contractor agrees to take affirmative action to employ, advance in employment, and otherwise treat qualified individuals with disabilities without discrimination based upon their physical or mental disability in all employment practices such as -

(i) Recruitment, advertising, and job application procedures;

(ii) Hiring, upgrading, promotion, award of tenure, demotion, transfer, layoff, termination, right of return from layoff, and rehiring;

(iii) Rates of pay or any other form of compensation and changes

in compensation;

(iv) Job assignments, job classifications, organizational structures, position descriptions, lines of progression, and seniority lists;

(v) Leaves of absence, sick leave, or any other leave;

(vi) Fringe benefits available by virtue of employment, whether or not administered by the Contractor;

(vii) Selection and financial support for training, including apprenticeships, professional meetings, conferences, and other related activities, and selection for leaves of absence to pursue training;

(viii) Activities sponsored by the Contractor, including social or recreational programs; and

(ix) Any other term, condition, or privilege of employment.

(2) The Contractor agrees to comply with the rules, regulations, and relevant orders of the Secretary of Labor (Secretary) issued under the Rehabilitation Act of 1973 (29 U.S.C. 793) (the Act), as amended.

(b) Postings. (1) The Contractor agrees to post employment notices stating--

(i) The Contractor's obligation under the law to take affirmative action to employ and advance in employment qualified individuals with disabilities; and

(ii) The rights of applicants and employees.

(2) These notices shall be posted in conspicuous places that are available to employees and applicants for employment. The Contractor shall ensure that applicants and employees with disabilities are informed of the contents of the notice (e.g., the Contractor may have the notice read to a visually disabled individual, or may lower the posted notice so that it might be read by a person in a wheelchair). The notices shall be in a form prescribed by the Deputy Assistant Secretary for Federal Contract Compliance of the U.S. Department of Labor (Deputy Assistant Secretary) and shall be provided by or through the Contracting Officer.

(3) The Contractor shall notify each labor union or representative of workers with which it has a collective bargaining agreement or other contract understanding, that the Contractor is bound by the terms of Section 503 of the Act and is committed to take affirmative action to employ, and advance in employment, qualified individuals with physical or mental disabilities.

(c) Noncompliance. If the Contractor does not comply with the requirements of this clause, appropriate actions may be taken under the rules, regulations, and relevant orders of the Secretary issued pursuant to the Act.

(d) Subcontracts. The Contractor shall include the terms of this clause in every subcontract or purchase order in excess of \$10,000 unless exempted by rules, regulations, or orders of the Secretary. The Contractor shall act as specified by the Deputy Assistant Secretary to enforce the terms, including action for noncompliance.

(End of clause)

39    52. 222- 37            EMPLOYMENT REPORTS ON    DISABLED VETERANS AND VETERANS OF THE  
   VIETNAM ERA (APR 1998)

(a) Unless the Contractor is a State or local government agency, the Contractor shall report at least annually, as required by the Secretary of Labor, on--

(1) The number of disabled veterans and the number of veterans of the Vietnam era in the workforce of the Contractor by job category and hiring location; and

(2) The total number of new employees hired during the period covered by the report, and of that total, the number of disabled veterans, and the number of veterans of the Vietnam era.

(b) The above items shall be reported by completing the form entitled "Federal Contractor Veterans' Employment Report VETS-100."

(c) Reports shall be submitted no later than March 31 of each year beginning March 31, 1988.

(d) The employment activity report required by paragraph (a)(2) of this clause shall reflect total hires during the most recent 12-month period as of the ending date selected for the employment profile report required by paragraph (a)(1) of this clause. Contractors may select an ending date:

(1) As of the end of any pay period during the period January through March 1st of the year the report is due, or (2) as of December 31, if the contractor has previous written approval from the Equal Employment Opportunity Commission to do so for purposes of submitting the Employer Information Report EE0-1 (Standard Form 100).

(e) The count of veterans reported according to paragraph (a) of this clause shall be based on voluntary disclosure. Each Contractor subject to the reporting requirements at 38 U.S.C. 4212 shall invite all disabled veterans and veterans of the Vietnam era who wish to benefit under the affirmative action program at 38 U.S.C. 4212 to identify themselves to the Contractor. The invitation shall state that the information is voluntarily provided; that the information will be kept confidential; that disclosure or refusal to provide the information will not subject the applicant or employee to any adverse treatment; and that the information will be used only in accordance with the regulations promulgated under 38 U.S.C. 4212.

(f) Subcontracts. The Contractor shall include the terms of this clause in every subcontract or purchase order of \$10,000 or more unless exempted by rules, regulations, or orders of the Secretary.

(End of clause)

40    52. 223- 2            CLEAN AIR AND WATER (APR 1984)

(a) "Air Act", as used in this clause, means the Clean Air Act (42 U.S.C. 7401, et seq.).

"Clean air standards," as used in this clause, means--

(1) Any enforceable rules, regulations, guidelines, standards, limitations, orders, controls, prohibitions, work practices, or other requirements contained in, issued under, or otherwise adopted under the Air Act or Executive Order 11738;

(2) An applicable implementation plan as described in section 110(d)

of the Air Act (42 U.S.C. 7410(d));

(3) An approved implementation procedure or plan under section 111(c) or section 111(d) of the Air Act (42 U.S.C. 7411(c) or (d)); or

(4) An approved implementation procedure under section 112(d) of the Air Act (42 U.S.C. 7412(d)).

"Clean water standards," as used in this clause, means any enforceable limitation, control, condition, prohibition, standard, or other requirement promulgated under the Water Act or contained in a permit issued to a discharger by the EPA or by a State under an approved program, as authorized by section 402 of the Water Act (33 U.S.C. 1342), or by local government to ensure compliance with pretreatment regulations as required by section 307 of the Water Act (33 U.S.C. 1317).

"Compliance," as used in this clause, means compliance with--

(1) Clean air or water standards; or

(2) A schedule or plan ordered or approved by a court of competent jurisdiction, the EPA, or an air or water pollution control agency under the requirements of the Air Act or Water Act and related regulations.

"Facility," as used in this clause, means any building, plant, installation, structure, mine, vessel or other floating craft, location, or site of operations, owned, leased, or supervised by a Contractor or subcontractor, used in the performance of a contract or subcontract. When a location or site of operations includes more than one building, plant, installation, or structure, the entire location or site shall be deemed a facility except when the Administrator, or a designee, of the EPA determines that independent facilities are collocated in one geographical area.

"Water Act," as used in this clause, means Clean Water Act (33 U.S.C. 1251, et seq.).

(b) The Contractor agrees--

(1) To comply with all the requirements of section 114 of the Clean Air Act (42 U.S.C. 7414) and section 308 of the Clean Water Act (33 U.S.C. 1318) relating to inspection, monitoring, entry, reports, and information, as well as other requirements specified in section 114 and section 308 of the Air Act and the Water Act, and all regulations and guidelines issued to implement those acts before the award of this contract;

(2) That no portion of the work required by this prime contract will be performed in a facility listed on the EPA List of Violating Facilities on the date when this contract was awarded unless and until the EPA eliminates the name of the facility from the listing;

(3) To use best efforts to comply with clean air standards and clean water standards at the facility in which the contract is being performed; and

(4) To insert the substance of this clause into any nonexempt subcontract, including this subparagraph (b)(4).

(End of clause)

(R 7-103.29 1975 OCT)

(R 1-1.2302)



(a) Executive Order 12856 of August 3, 1993, requires Federal facilities to comply with the provisions of the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA) (42 U.S.C. 11001-11050) and the Pollution Prevention Act of 1990 (PPA) (42 U.S.C. 13101-13109).

(b) The Contractor shall provide all information needed by the Federal facility to comply with the emergency planning reporting requirements of Section 302 of EPCRA; the emergency notice requirements of Section 304 of EPCRA; the list of Material Data Safety Sheets required by Section 311 of EPCRA; the emergency and hazardous chemical inventory forms of Section 312 of EPCRA; the toxic chemical release inventory of Section 313 of EPCRA, which includes the reduction and recycling information required by Section 6607 of PPA; and the toxic chemical reduction goals requirements of Section 3-302 of Executive Order 12856.

(End of clause)

(a) Definitions. As used in this clause--

"Controlled substance" means a controlled substance in schedules I through V of section 202 of the Controlled Substances Act (21 U.S.C. 812) and as further defined in regulation at 21 CFR 1308.11 - 1308.15.

"Conviction" means a finding of guilt (including a plea of nolo contendere) or imposition of sentence, or both, by any judicial body charged with the responsibility to determine violations of the Federal or State criminal drug statutes.

"Criminal drug statute" means a Federal or non-Federal criminal statute involving the manufacture, distribution, dispensing, possession or use of any controlled substance.

"Drug-free workplace" means the site(s) for the performance of work done by the Contractor in connection with a specific contract at which employees of the Contractor are prohibited from engaging in the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance.

"Employee" means an employee of a Contractor directly engaged in the performance of work under a Government contract. "Directly engaged" is defined to include all direct cost employees and any other Contractor employee who has other than a minimal impact or involvement in contract performance.

"Individual" means an offeror/contractor that has no more than one employee including the offeror/contractor.

(b) The Contractor, if other than an individual, shall--within 30 days after award (unless a longer period is agreed to in writing for contracts of 30 days or more performance duration), or as soon as possible for contracts of less than 30 days performance duration--

(1) Publish a statement notifying its employees that the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance is prohibited in the Contractor's workplace and specifying the actions that will be taken against employees for violations of such prohibition;

(2) Establish an ongoing drug-free awareness program to inform such

employees about--

- (i) The dangers of drug abuse in the workplace;
  - (ii) The Contractor's policy of maintaining a drug-free workplace;
  - (iii) Any available drug counseling, rehabilitation, and employee assistance programs; and
  - (iv) The penalties that may be imposed upon employees for drug abuse violations occurring in the workplace;
- (3) Provide all employees engaged in performance of the contract with a copy of the statement required by subparagraph (b)(1) of this clause;
- (4) Notify such employees in writing in the statement required by subparagraph (b)(1) of this clause that, as a condition of continued employment on this contract, the employee will--
- (i) Abide by the terms of the statement; and
  - (ii) Notify the employer in writing of the employee's conviction under a criminal drug statute for a violation occurring in the workplace no later than 5 days after such conviction.
- (5) Notify the Contracting Officer in writing within 10 days after receiving notice under subdivision (b)(4)(ii) of this clause, from an employee or otherwise receiving actual notice of such conviction. The notice shall include the position title of the employee;
- (6) Within 30 days after receiving notice under subdivision (b)(4)(ii) of this clause of a conviction, take one of the following actions with respect to any employee who is convicted of a drug abuse violation occurring in the workplace:
- (i) Taking appropriate personnel action against such employee, up to and including termination; or
  - (ii) Require such employee to satisfactorily participate in a drug abuse assistance or rehabilitation program approved for such purposes by a Federal, State, or local health, law enforcement, or other appropriate agency, and
- (7) Make a good faith effort to maintain a drug-free workplace through implementation of subparagraphs (b)(1) through (b)(6) of this clause.
- (c) The Contractor, if an individual, agrees by award of the contract or acceptance of a purchase order, not to engage in the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance while performing this contract.
- (d) In addition to other remedies available to the Government, the Contractor's failure to comply with the requirements of paragraph (b) or (c) of this clause may, pursuant to FAR 23.506, render the Contractor subject to suspension of contract payments, termination of the contract for default, and suspension or debarment.

(End of clause)

43    52.223-14            TOXIC CHEMICAL RELEASE REPORTING (OCT 1996)

(a) Unless otherwise exempt, the Contractor, as owner or operator of a facility used in the performance of this contract, shall file by July 1 for the prior calendar year an annual Toxic Chemical Release Inventory Form (Form R) as described in sections 313(a) and (g) of the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA) (42 U. S. C. 11023(a) and

(g)), and section 6607 of the Pollution Prevention Act of 1990 (PPA) (42 U.S.C. 13106). The Contractor shall file, for each facility subject to the Form R filing and reporting requirements, the annual Form R throughout the life of the contract.

(b) A Contractor owned or operated facility used in the performance of this contract is exempt from the requirement to file an annual Form R if--

(1) The facility does not manufacture, process, or otherwise use any toxic chemicals listed under section 313(c) of EPCRA, 42 U.S.C. 11023(c);

(2) The facility does not have 10 or more full-time employees as specified in section 313(b)(1)(A) of EPCRA, 42 U.S.C. 11023(b)(1)(A);

(3) The facility does not meet the reporting thresholds of toxic chemicals established under section 313(f) of EPCRA, 42 U.S.C. 11023(f) (including the alternate thresholds at 40 CFR 372.27, provided an appropriate certification form has been filed with EPA);

(4) The facility does not fall within Standard Industrial Classification Code (SIC) designations 20 through 39 as set forth in Section 19.102 of the Federal Acquisition Regulation (FAR); or

(5) The facility is not located within any State of the United States, the District of Columbia, the Commonwealth of Puerto Rico, Guam, American Samoa, the United States Virgin Islands, the Northern Mariana Islands, or any other territory or possession over which the United States has jurisdiction.

(c) If the Contractor has certified to an exemption in accordance with one or more of the criteria in paragraph (b) of this clause, and after award of the contract circumstances change so that any of its owned or operated facilities used in the performance of this contract is no longer exempt--

(1) The Contractor shall notify the Contracting Officer; and

(2) The Contractor, as owner or operator of a facility used in the performance of this contract that is no longer exempt, shall (i) submit a Toxic Chemical Release Inventory Form (Form R) on or before July 1 for the prior calendar year during which the facility becomes eligible; and (ii) continue to file the annual Form R for the life of the contract for such facility.

(d) The Contracting Officer may terminate this contract or take other action as appropriate, if the Contractor fails to comply accurately and fully with the EPCRA and PPA toxic chemical release filing and reporting requirements.

(e) Except for acquisitions of commercial items as defined in FAR Part 2, the Contractor shall--

(1) For competitive subcontracts expected to exceed \$100,000 (including all options), include a solicitation provision substantially the same as the provision at FAR 52.223-13, Certification of Toxic Chemical Release Reporting; and

(2) Include in any resultant subcontract exceeding \$100,000 (including all options), the substance of this clause, except this paragraph (e).

(End of clause)

(a) Unless advance written approval of the Contracting Officer is

obtained, the Contractor shall not acquire, for use in the performance of this contract, any supplies or services originating from sources within, or that were located in or transported from or through, countries whose products are banned from importation into the United States by Executive order or regulations of the Office of Foreign Assets Control, Department of the Treasury. Those countries include Cuba, Iran, Iraq, Libya, North Korea, and Sudan.

(b) The Contractor shall not acquire for use in the performance of this contract any supplies or services from entities controlled by the Government of Iraq.

(c) The Contractor agrees to insert the provisions of this clause, including this paragraph (c), in all subcontracts hereunder.

(End of clause)

45     52.225-15            BUY AMERICAN ACT--CONSTRUCTION MATERIALS UNDER TRADE  
                                 AGREEMENTS ACT AND NORTH AMERICAN FREE TRADE AGREEMENT  
                                 (JUN 1997)

(a) Definitions. As used in this clause--

"Components" means those articles, materials, and supplies incorporated directly into construction materials.

"Construction material" means an article, material, or supply brought to the construction site for incorporation into the building or work. Construction material also includes an item brought to the site pre-assembled from articles, materials, or supplies. However, emergency life safety systems, such as emergency lighting, fire alarm, and audio evacuation systems, which are discrete systems incorporated into a public building or work and which are produced as a complete system, shall be evaluated as a single and distinct construction material regardless of when or how the individual parts or components of such systems are delivered to the construction site.

"Designated country construction material" means a construction material that (a) is wholly the growth, product, or manufacture of a designated country (as defined at FAR 25.401), or (b) in the case of a construction material which consists in whole or in part of materials from another country or instrumentality, has been substantially transformed in a designated country into a new and different construction material distinct from the materials from which it was transformed.

"Domestic construction material" means (1) an unmanufactured construction material mined or produced in the United States, or (2) a construction material manufactured in the United States, if the cost of its components mined, produced, or manufactured in the United States exceeds 50 percent of the cost of all its components. Components of foreign origin of the same class or kind as the construction materials determined to be unavailable pursuant to subparagraph 25.202(a)(2) of the Federal Acquisition Regulation (FAR) shall be treated as domestic.

"North American Free Trade Agreement (NAFTA) country" means Canada or Mexico.

"NAFTA country construction material" means a construction material that (a) is wholly the growth, product, or manufacture of a NAFTA country, or (b) in the case of a construction material which consists in whole or in

part of materials from another country or instrumentality, has been substantially transformed in a NAFTA country into a new and different construction material distinct from the materials from which it was transformed.

(b)(1) The Buy American Act (41 U.S.C. 10a--10d) requires that only domestic construction material be used in performing this contract, except as provided in paragraphs (b)(2), (b)(3), and (b)(4) of this clause.

(2) The Trade Agreements Act and the North American Free Trade Agreement (NAFTA) provide that designated country and NAFTA country construction materials are exempted from application of the Buy American Act.

(3) The requirement in paragraph (b)(1) of this clause does not apply to the excepted construction material or components listed by the Government as follows:

%%Insert list of applicable accepted materials or indicate "none"  
none

(4) Other foreign construction material may be added to the list in paragraph (b)(3) of this clause if the Government determines that--

(i) The cost would be unreasonable (the cost of a particular domestic construction material shall be determined to be unreasonable when the cost of such material exceeds the cost of foreign material by more than 6 percent, unless the agency head determines a higher percentage to be appropriate);

(ii) The application of the restriction of the Buy American Act to a particular construction material would be impracticable or inconsistent with the public interest; or (iii) The construction material is not mined, produced, or manufactured in the United States in sufficient and reasonably available commercial quantities of a satisfactory quality.

(5) The Contractor agrees that only domestic construction materials, NAFTA country construction materials, or designated country construction materials will be used by the Contractor, subcontractors, material men, and suppliers in the performance of this contract, except for foreign construction materials, if any, listed in paragraph (b)(3) of this clause.

(c) Request for determination.

(1) Contractors requesting to use foreign construction material under paragraph (b)(4) of this clause shall provide adequate information for Government evaluation of the request for a determination regarding the inapplicability of the Buy American Act. Each submission shall include a description of the foreign and domestic construction materials, including unit of measure, quantity, price, time of delivery or availability, location of the construction project, name and address of the proposed contractor, and a detailed justification of the reason for use of foreign materials cited in accordance with paragraph (b)(4) of this clause. A submission based on unreasonable cost shall include a reasonable survey of the market and a completed price comparison table in the format in paragraph (d) of this clause. The price of construction material shall include all delivery costs to the construction site and any applicable duty (whether or not a duty-free certificate may be issued).

(2) If the Government determines after contract award that an exception to the Buy American Act applies, the contract shall be modified to allow use of the foreign construction material, and adequate consideration

shall be negotiated. However, when the basis for the exception is the unreasonable price of a domestic construction material, adequate consideration shall not be less than the differential established in paragraph (b)(4)(i) of this clause.

(3) If the Government does not determine that an exception to the Buy American Act applies, the use of that particular foreign construction material will be a failure to comply with the Act.

(d) For evaluation of requests under paragraph (c) of this clause based on unreasonable cost, the following information and any applicable supporting data based on the survey of suppliers shall be included in the request:

**Foreign and Domestic Construction Materials Price Comparison**

Construction material description	Unit of measure	Quantity	Price (dollars) +
Item 1: Foreign construction material			
Domestic construction material			
Item 2: Foreign construction material			
Domestic construction material			

List name, address, telephone number, and contact for suppliers surveyed. Attach copy of response; if oral, attach summary. Include other applicable supporting information.

+ Include all delivery costs to the construction site and any applicable duty (whether or not a duty-free entry certificate is issued).

(End of clause)

**46 52. 226- 1 UTILIZATION OF INDIAN ORGANIZATIONS AND INDIAN-OWNED ECONOMIC ENTERPRISES (SEP 1996)**

(a) For Department of Defense contracts, this clause applies only if the contract includes a subcontracting plan incorporated under the terms of the clause at 52.219-9, Small, Small Disadvantaged and Women-Owned Small Business Subcontracting Plan. It does not apply to contracts awarded based on a subcontracting plan submitted and approved under paragraph (g) of the clause at 52.219

(b) Definitions. As used in this clause:

"Indian" means any person who is a member of any Indian tribe, band, group, pueblo or community which is recognized by the Federal Government as eligible for services from the Bureau of Indian Affairs (BIA) in accordance with 25 U.S.C. 1452(c) and any "Native" as defined in the Alaska Native Claims Settlement Act (43 U.S.C. 1601).

"Indian organization" means the governing body of any Indian tribe or entity established or recognized by the governing body of an Indian tribe for the purposes of 25 U.S.C., Chapter 17.

"Indian-owned economic enterprise" means any Indian-owned (as determined by the Secretary of the Interior) commercial, industrial, or business activity established or organized for the purpose of profit, provided that Indian ownership shall constitute not less than 51 percent of the enterprise.

"Indian tribe" means any Indian tribe, band, group, pueblo or community, including native villages and native groups (including corporations

organized by Kenai, Juneau, Sitka, and Kodiak) as defined in the Alaska Native Claims Settlement Act, which is recognized by the Federal Government as eligible for services from BIA in accordance with 25 U.S.C. 1542(c).

"Interested party" means a prime contractor or an actual or prospective offeror whose direct economic interest would be affected by the award of a subcontract or by the failure to award a subcontract.

(c) The Contractor agrees to use its best efforts to give Indian organizations and Indian-owned economic enterprises (25 U.S.C. 1544) the maximum practicable opportunity to participate in the subcontracts it awards to the fullest extent consistent with efficient performance of its contract.

(1) The Contracting Officer and the Contractor, acting in good faith, may rely on the self-certification of an Indian organization or Indian-owned economic enterprise as to its eligibility, unless an interested party challenges its status or the Contracting Officer has independent reason to question that status. In the event of a challenge to the self-certification of a subcontractor, the Contracting Officer shall refer the matter to the U.S. Department of the Interior, Bureau of Indian Affairs (BIA), Attn: Chief, Division of Contracting and Grants Administration, 1849 C Street, NW, MS-334A-SIB, Washington, DC 20245. The BIA will determine the eligibility and notify the Contracting Officer. The 5 percent incentive payment will not be made within 50 working days of subcontract award or while a challenge is pending. If a subcontractor is determined to be an ineligible participant, no incentive payment will be made under the Indian Incentive Program.

(2) The Contractor may request an adjustment under the Indian Incentive Program to the following:

- (i) The estimated cost of a cost-type contract.
- (ii) The target cost of a cost-plus-incentive-fee prime contract.
- (iii) The target cost and ceiling price of a fixed-price incentive prime contract.
- (iv) The price of a firm-fixed-price prime contract.

(3) The amount of the equitable adjustment to the prime contract shall be 5 percent of the estimated cost, target cost or firm-fixed-price included in the subcontract initially awarded to the Indian organization or Indian-owned economic enterprise.

(4) The Contractor has the burden of proving the amount claimed and must assert its request for an adjustment prior to completion of contract performance.

(d) The Contracting Officer, subject to the terms and conditions of the contract and the availability of funds, shall authorize an incentive payment of 5 percent of the amount paid to the subcontractor. Contracting Officers shall seek funding in accordance with agency procedures. The Contracting Officer's decision is final and not subject to the Disputes clause of this contract.

(End of clause)

(a) The Government authorizes and consents to all use and manufacture, in performing this contract or any subcontract at any tier, of any invention described in and covered by a United States patent (1) embodied in the structure or composition of any article the delivery of which is accepted by the Government under this contract or (2) used in machinery, tools, or methods whose use necessarily results from compliance by the Contractor or a subcontractor with (i) specifications or written provisions forming a part of this contract or (ii) specific written instructions given by the Contracting Officer directing the manner of performance. The entire liability to the Government for infringement of a patent of the United States shall be determined solely by the provisions of the indemnity clause, if any, included in this contract or any subcontract hereunder (including any lower-tier subcontract), and the Government assumes liability for all other infringement to the extent of the authorization and consent hereinabove granted.

(b) The Contractor agrees to include, and require inclusion of, this clause, suitably modified to identify the parties, in all subcontracts at any tier for supplies or services (including construction, architect-engineer services, and materials, supplies, models, samples, and design or testing services expected to exceed the simplified acquisition threshold); however, omission of this clause from any subcontract, including those at or below the simplified acquisition threshold, does not affect this authorization and consent.

(End of clause)

(a) The Contractor shall report to the Contracting Officer, promptly and in reasonable written detail, each notice or claim of patent or copyright infringement based on the performance of this contract of which the Contractor has knowledge.

(b) In the event of any claim or suit against the Government on account of any alleged patent or copyright infringement arising out of the performance of this contract or out of the use of any supplies furnished or work or services performed under this contract, the Contractor shall furnish to the Government, when requested by the Contracting Officer, all evidence and information in possession of the Contractor pertaining to such suit or claim. Such evidence and information shall be furnished at the expense of the Government except where the Contractor has agreed to indemnify the Government.

(c) The Contractor agrees to include, and require inclusion of, this clause in all subcontracts at any tier for supplies or services (including construction and architect-engineer subcontracts and those for material, supplies, models, samples, or design or testing services) expected to exceed the simplified acquisition threshold at FAR 2.101.

(End of clause)



49     52. 227- 4            PATENT INDEMNITY-- CONSTRUCTION CONTRACTS (APR 1984)

Except as otherwise provided, the Contractor agrees to indemnify the Government and its officers, agents, and employees against liability, including costs and expenses, for infringement upon any United States patent (except a patent issued upon an application that is now or may hereafter be withheld from issue pursuant to a Secrecy Order under 35 U. S. C. 181) arising out of performing this contract or out of the use or disposal by or for the account of the Government of supplies furnished or work performed under this contract.

(End of clause)  
(R 7-602.16 1964 JUN)

50     52. 228- 2            ADDITIONAL BOND SECURITY (OCT 1997)

The Contractor shall promptly furnish additional security required to protect the Government and persons supplying labor or materials under this contract if--

(a) Any surety upon any bond, or issuing financial institution for other security, furnished with this contract becomes unacceptable to the Government;

(b) Any surety fails to furnish reports on its financial condition as required by the Government;

(c) The contract price is increased so that the penal sum of any bond becomes inadequate in the opinion of the Contracting Officer; or

(d) An irrevocable letter of credit (ILC) used as security will expire before the end of the period of required security. If the Contractor does not furnish an acceptable extension or replacement ILC, or other acceptable substitute, at least 30 days before an ILC's scheduled expiration, the Contracting officer has the right to immediately draw on the ILC.

(End of clause)

51     52. 228- 5            INSURANCE-- WORK ON A GOVERNMENT INSTALLATION (JAN 1997)

(a) The Contractor shall, at its own expense, provide and maintain during the entire performance of this contract, at least the kinds and minimum amounts of insurance required in the Schedule or elsewhere in the contract.

(b) Before commencing work under this contract, the Contractor shall notify the Contracting Officer in writing that the required insurance has been obtained. The policies evidencing required insurance shall contain an endorsement to the effect that any cancellation or any material change adversely affecting the Government's interest shall not be effective (1) for such period as the laws of the State in which this contract is to be performed prescribe, or (2) until 30 days after the insurer or the Contractor gives written notice to the Contracting Officer, whichever period is longer.

(c) The Contractor shall insert the substance of this clause, including this paragraph (c), in subcontracts under this contract that require work on a Government installation and shall require subcontractors to provide

and maintain the insurance required in the Schedule or elsewhere in the contract. The Contractor shall maintain a copy of all subcontractors' proofs of required insurance, and shall make copies available to the Contracting Officer upon request.

(End of clause)

52    52. 228- 11            PLEDGES OF ASSETS (FEB 1992)

(a) Offerors shall obtain from each person acting as an individual surety on a bid guarantee, a performance bond, or a payment bond--

(1) Pledge of assets; and

(2) Standard Form 28, Affidavit of Individual Surety.

(b) Pledges of assets from each person acting as an individual surety shall be in the form of--

(1) Evidence of an escrow account containing cash, certificates of deposit, commercial or Government securities, or other assets described in FAR 28.203-2 (except see 28.203-2(b)(2) with respect to Government securities held in book entry form) and/or;

(2) A recorded lien on real estate. The offeror will be required to provide--

(i) Evidence of title in the form of a certificate of title prepared by a title insurance company approved by the United States Department of Justice. This title evidence must show fee simple title vested in the surety along with any concurrent owners; whether any real estate taxes are due and payable; and any recorded encumbrances against the property, including the lien filed in favor of the Government as required by FAR 28.203-3(d);

(ii) Evidence of the amount due under any encumbrance shown in the evidence of title;

(iii) A copy of the current real estate tax assessment of the property or a current appraisal dated no earlier than 6 months prior to the date of the bond, prepared by a professional appraiser who certifies that the appraisal has been conducted in accordance with the generally accepted appraisal standards as reflected in the Uniform Standards of Professional Appraisal Practice, as promulgated by the Appraisal Foundation.

(End of clause)

53    52. 228- 12            PROSPECTIVE SUBCONTRACTOR REQUESTS FOR BONDS (OCT 1995)

In accordance with Section 806(a)(3) of Pub. L. 102-190, as amended by Sections 2091 and 8105 of Pub. L. 103-355, upon the request of a prospective subcontractor or supplier offering to furnish labor or material for the performance of this contract for which a payment bond has been furnished to the Government pursuant to the Miller Act, the Contractor shall promptly provide a copy of such payment bond to the requester.

(End of clause)

(a) "Contract date," as used in this clause, means the date set for bid opening or, if this is a negotiated contract or a modification, the effective date of this contract or modification.

"All applicable Federal, State, and local taxes and duties," as used in this clause, means all taxes and duties, in effect on the contract date, that the taxing authority is imposing and collecting on the transactions or property covered by this contract.

"After-imposed Federal tax," as used in this clause, means any new or increased Federal excise tax or duty, or tax that was exempted or excluded on the contract date but whose exemption was later revoked or reduced during the contract period, on the transactions or property covered by this contract that the Contractor is required to pay or bear as the result of legislative, judicial, or administrative action taking effect after the contract date. It does not include social security tax or other employment taxes.

"After-relieved Federal tax," as used in this clause, means any amount of Federal excise tax or duty, except social security or other employment taxes, that would otherwise have been payable on the transactions or property covered by this contract, but which the Contractor is not required to pay or bear, or for which the Contractor obtains a refund or drawback, as the result of legislative, judicial, or administrative action taking effect after the contract date.

(b) The contract price includes all applicable Federal, State, and local taxes and duties.

(c) The contract price shall be increased by the amount of any after-imposed Federal tax, provided the Contractor warrants in writing that no amount for such newly imposed Federal excise tax or duty or rate increase was included in the contract price, as a contingency reserve or otherwise.

(d) The contract price shall be decreased by the amount of any after-relieved Federal tax.

(e) The contract price shall be decreased by the amount of any Federal excise tax or duty, except social security or other employment taxes, that the Contractor is required to pay or bear, or does not obtain a refund of, through the Contractor's fault, negligence, or failure to follow instructions of the Contracting Officer.

(f) No adjustment shall be made in the contract price under this clause unless the amount of the adjustment exceeds \$250.

(g) The Contractor shall promptly notify the Contracting Officer of all matters relating to any Federal excise tax or duty that reasonably may be expected to result in either an increase or decrease in the contract price and shall take appropriate action as the Contracting Officer directs.

(h) The Government shall, without liability, furnish evidence appropriate to establish exemption from any Federal, State, or local tax when the Contractor requests such evidence and a reasonable basis exists to sustain the exemption.

(End of clause)

(a) Payment of price. The Government shall pay the Contractor the contract price as provided in this contract.

(b) Progress payments. The Government shall make progress payments monthly as the work proceeds, or at more frequent intervals as determined by the Contracting Officer, on estimates of work accomplished which meets the standards of quality established under the contract, as approved by the Contracting Officer.

(1) The Contractor's request for progress payments shall include the following substantiation:

(i) An itemization of the amounts requested, related to the various elements of work required by the contract covered by the payment requested.

(ii) A listing of the amount included for work performed by each subcontractor under the contract.

(iii) A listing of the total amount of each subcontract under the contract.

(iv) A listing of the amounts previously paid to each such subcontractor under the contract.

(v) Additional supporting data in a form and detail required by the Contracting Officer.

(2) In the preparation of estimates, the Contracting Officer may authorize material delivered on the site and preparatory work done to be taken into consideration. Material delivered to the Contractor at locations other than the site also may be taken into consideration if--

(i) Consideration is specifically authorized by this contract; and

(ii) The Contractor furnishes satisfactory evidence that it has acquired title to such material and that the material will be used to perform this contract.

(c) Contractor certification. Along with each request for progress payments, the Contractor shall furnish the following certification, or payment shall not be made: (However, if the Contractor elects to delete paragraph (c)(4) from the certification, the certification is still acceptable.)

I hereby certify, to the best of my knowledge and belief, that--

(1) The amounts requested are only for performance in accordance with the specifications, terms, and conditions of the contract;

(2) Payments to subcontractors and suppliers have been made from previous payments received under the contract, and timely payments will be made from the proceeds of the payment covered by this certification, in accordance with subcontract agreements and the requirements of chapter 39 of Title 31, United States Code;

(3) This request for progress payments does not include any amounts which the prime contractor intends to withhold or retain from a subcontractor or supplier in accordance with the terms and conditions of the subcontract; and

(4) This certification is not to be construed as final acceptance of a subcontractor's performance.

\_\_\_\_\_  
(Name)

\_\_\_\_\_  
(Title)

\_\_\_\_\_  
(Date)

(d) Refund of unearned amounts. If the Contractor, after making a certified request for progress payments, discovers that a portion or all of such request constitutes a payment for performance by the Contractor that fails to conform to the specifications, terms, and conditions of this contract (hereinafter referred to as the "unearned amount"), the Contractor shall--

(1) Notify the Contracting Officer of such performance deficiency; and

(2) Be obligated to pay the Government an amount (computed by the Contracting Officer in the manner provided in paragraph (j) of this clause) equal to interest on the unearned amount from the 8th day after the date of receipt of the unearned amount until--

(i) The date the Contractor notifies the Contracting Officer that the performance deficiency has been corrected; or

(ii) The date the Contractor reduces the amount of any subsequent certified request for progress payments by an amount equal to the unearned amount.

(e) Retainage. If the Contracting Officer finds that satisfactory progress was achieved during any period for which a progress payment is to be made, the Contracting Officer shall authorize payment to be made in full. However, if satisfactory progress has not been made, the Contracting Officer may retain a maximum of 10 percent of the amount of the payment until satisfactory progress is achieved. When the work is substantially complete, the Contracting Officer may retain from previously withheld funds and future progress payments that amount the Contracting Officer considers adequate for protection of the Government and shall release to the Contractor all the remaining withheld funds. Also, on completion and acceptance of each separate building, public work, or other division of the contract, for which the price is stated separately in the contract, payment shall be made for the completed work without retention of a percentage.

(f) Title, liability, and reservation of rights. All material and work covered by progress payments made shall, at the time of payment, become the sole property of the Government, but this shall not be construed as--

(1) Relieving the Contractor from the sole responsibility for all material and work upon which payments have been made or the restoration of any damaged work; or

(2) Waiving the right of the Government to require the fulfillment of all of the terms of the contract.

(g) Reimbursement for bond premiums. In making these progress payments, the Government shall, upon request, reimburse the Contractor for the amount of premiums paid for performance and payment bonds (including coinsurance and reinsurance agreements, when applicable) after the Contractor has furnished evidence of full payment to the surety. The retainage provisions in paragraph (e) of this clause shall not apply to that portion of progress payments attributable to bond premiums.

(h) Final payment. The Government shall pay the amount due the Contractor under this contract after--

- (1) Completion and acceptance of all work;
- (2) Presentation of a properly executed voucher; and
- (3) Presentation of release of all claims against the Government arising by virtue of this contract, other than claims, in stated amounts, that the Contractor has specifically excepted from the operation of the release. A release may also be required of the assignee if the Contractor's claim to amounts payable under this contract has been assigned under the Assignment of Claims Act of 1940 (31 U.S.C. 3727 and 41 U.S.C. 15).

(i) Limitation because of undefinitized work. Notwithstanding any provision of this contract, progress payments shall not exceed 80 percent on work accomplished on undefinitized contract actions. A "contract action" is any action resulting in a contract, as defined in FAR Subpart 2.1, including contract modifications for additional supplies or services, but not including contract modifications that are within the scope and under the terms of the contract, such as contract modifications issued pursuant to the Changes clause, or funding and other administrative changes.

(j) Interest computation on unearned amounts. In accordance with 31 U.S.C. 3903(c)(1), the amount payable under subparagraph (d)(2) of this clause shall be--

- (1) Computed at the rate of average bond equivalent rates of 91-day Treasury bills auctioned at the most recent auction of such bills prior to the date the Contractor receives the unearned amount; and
  - (2) Deducted from the next available payment to the Contractor.
- (End of clause)

56     52.232-17     INTEREST (JUN 1996)

(a) Except as otherwise provided in this contract under a Price Reduction for Defective Cost or Pricing Data clause or a Cost Accounting Standards clause, all amounts that become payable by the Contractor to the Government under this contract (net of any applicable tax credit under the Internal Revenue Code (26 U.S.C. 1481)) shall bear simple interest from the date due until paid unless paid within 30 days of becoming due. The interest rate shall be the interest rate established by the Secretary of the Treasury as provided in Section 12 of the Contract Disputes Act of 1978 (Public Law 95-563), which is applicable to the period in which the amount becomes due, as provided in paragraph (b) of this clause, and then at the rate applicable for each six-month period as fixed by the Secretary until the amount is paid.

(b) Amounts shall be due at the earliest of the following dates:

- (1) The date fixed under this contract.
- (2) The date of the first written demand for payment consistent with this contract, including any demand resulting from a default termination.
- (3) The date the Government transmits to the Contractor a proposed supplemental agreement to confirm completed negotiations establishing the amount of debt.
- (4) If this contract provides for revision of prices, the date of

written notice to the Contractor stating the amount of refund payable in connection with a pricing proposal or a negotiated pricing agreement not confirmed by contract modification.

(c) The interest charge made under this clause may be reduced under the procedures prescribed in 32.614-2 of the Federal Acquisition Regulation in effect on the date of this contract.

(End of clause)

57 52.232-23 ASSIGNMENT OF CLAIMS (JAN 1986)

(a) The Contractor, under the Assignment of Claims Act, as amended, 31 U.S.C. 3727, 41 U.S.C. 15 (hereafter referred to as "the Act"), may assign its rights to be paid amounts due or to become due as a result of the performance of this contract to a bank, trust company, or other financing institution, including any Federal lending agency. The assignee under such an assignment may thereafter further assign or reassign its right under the original assignment to any type of financing institution described in the preceding sentence.

(b) Any assignment or reassignment authorized under the Act and this clause shall cover all unpaid amounts payable under this contract, and shall not be made to more than one party, except that an assignment or reassignment may be made to one party as agent or trustee for two or more parties participating in the financing of this contract.

(c) The Contractor shall not furnish or disclose to any assignee under this contract any classified document (including this contract) or information related to work under this contract until the Contracting Officer authorizes such action in writing.

(End of clause)

58 52.232-27 PROMPT PAYMENT FOR CONSTRUCTION CONTRACTS (JUN 1997)

Notwithstanding any other payment terms in this contract, the Government will make invoice payments and contract financing payments under the terms and conditions specified in this clause. Payment shall be considered as being made on the day a check is dated or the date of an electronic funds transfer. Definitions of pertinent terms are set forth in section 32.902 of the Federal Acquisition Regulation. All days referred to in this clause are calendar days, unless otherwise specified. (However, see subparagraph (a)(3) concerning payments due on Saturdays, Sundays, and legal holidays.)

(a) Invoice payments--

(1) Types of invoice payments. For purposes of this clause, there are several types of invoice payments that may occur under this contract, as follows:

(i) Progress payments, if provided for elsewhere in this contract, based on Contracting Officer approval of the estimated amount and value of work or services performed, including payments for reaching milestones in any project:

(A) The due date for making such payments shall be 14 days after receipt of the payment request by the designated billing office. If the designated billing office fails to annotate the payment request

with the actual date of receipt at the time of receipt, the payment due date shall be the 14th day after the date of the Contractor's payment request, provided a proper payment request is received and there is no disagreement over quantity, quality, or Contractor compliance with contract requirements.

(B) The due date for payment of any amounts retained by the Contracting Officer in accordance with the clause at 52.232-5, Payments Under Fixed-Price Construction Contracts, shall be as specified in the contract or, if not specified, 30 days after approval for release to the Contractor by the Contracting Officer.

(ii) Final payments based on completion and acceptance of all work and presentation of release of all claims against the Government arising by virtue of the contract, and payments for partial deliveries that have been accepted by the Government (e.g., each separate building, public work, or other division of the contract for which the price is stated separately in the contract):

(A) The due date for making such payments shall be either the 30th day after receipt by the designated billing office of a proper invoice from the Contractor, or the 30th day after Government acceptance of the work or services completed by the Contractor, whichever is later. If the designated billing office fails to annotate the invoice with the date of actual receipt at the time of receipt, the invoice payment due date shall be the 30th day after the date of the Contractor's invoice, provided a proper invoice is received and there is no disagreement over quantity, quality, or Contractor compliance with contract requirements.

(B) On a final invoice where the payment amount is subject to contract settlement actions (e.g., release of claims), acceptance shall be deemed to have occurred on the effective date of the contract settlement.

(2) Contractor's invoice. The Contractor shall prepare and submit invoices to the designated billing office specified in the contract. A proper invoice must include the items listed in paragraphs (a)(2)(i) through (a)(2)(ix) of this clause. If the invoice does not comply with these requirements, it shall be returned within 7 days after the date the designated billing office received the invoice, with a statement of the reasons why it is not a proper invoice. Untimely notification will be taken into account in computing any interest penalty owed the Contractor in the manner described in subparagraph (a)(4) of this clause.

(i) Name and address of the Contractor.

(ii) Invoice date. (The Contractor is encouraged to date invoices as close as possible to the date of mailing or transmission.)

(iii) Contract number or other authorization for work or services performed (including order number and contract line item number).

(iv) Description of work or services performed.

(v) Delivery and payment terms (e.g., prompt payment discount terms).

(vi) Name and address of Contractor official to whom payment is to be sent (must be the same as that in the contract or in a proper notice of assignment).

(vii) Name (where practicable), title, phone number, and mailing address of person to be notified in the event of a defective invoice.

(viii) For payments described in paragraph (a)(1)(i) of this clause,



substantiation of the amounts requested and certification in accordance with the requirements of the clause at 52.232-5, Payments Under Fixed-Price Construction Contracts.

(ix) Any other information or documentation required by the contract.

(x) While not required, the Contractor is strongly encouraged to assign an identification number to each invoice.

(3) Interest penalty. An interest penalty shall be paid automatically by the designated payment office, without request from the Contractor, if payment is not made by the due date and the conditions listed in paragraphs (a)(3)(i) through (a)(3)(iii) of this clause are met, if applicable. However, when the due date falls on a Saturday, Sunday, or legal holiday when Federal Government offices are closed and Government business is not expected to be conducted, payment may be made on the following business day without incurring a late payment interest penalty.

(i) A proper invoice was received by the designated billing office.

(ii) A receiving report or other Government documentation authorizing payment was processed and there was no disagreement over quantity, quality, Contractor compliance with any contract term or condition, or requested progress payment amount.

(iii) In the case of a final invoice for any balance of funds due the Contractor for work or services performed, the amount was not subject to further contract settlement actions between the Government and the Contractor.

(4) Computing penalty amount. The interest penalty shall be at the rate established by the Secretary of the Treasury under section 12 of the Contract Disputes Act of 1978 (41 U.S.C. 611) that is in effect on the day after the due date, except where the interest penalty is prescribed by other governmental authority (e.g., tariffs). This rate is referred to as the "Renegotiation Board Interest Rate," and it is published in the Federal Register semiannually on or about January 1 and July 1. The interest penalty shall accrue daily on the invoice principal payment amount approved by the Government until the payment date of such approved principal amount; and will be compounded in 30-day increments inclusive from the first day after the due date through the payment date. That is, interest accrued at the end of any 30-day period will be added to the approved invoice principal payment amount and will be subject to interest penalties if not paid in the succeeding 30-day period. If the designated billing office failed to notify the Contractor of a defective invoice within the periods prescribed in subparagraph (a)(2) of this clause, the due date on the corrected invoice will be adjusted by subtracting from such date the number of days taken beyond the prescribed notification of defects period. Any interest penalty owed the Contractor will be based on this adjusted due date. Adjustments will be made by the designated payment office for errors in calculating interest penalties.

(i) For the sole purpose of computing an interest penalty that might be due the Contractor for payments described in paragraph (a)(1)(ii) of this clause, Government acceptance or approval shall be deemed to have occurred constructively on the 7th day after the Contractor has completed the work or services in accordance with the terms and conditions of the contract. In the event that actual acceptance or approval occurs within the constructive acceptance or approval period, the determination of an interest penalty shall be based on the actual

date of acceptance or approval. Constructive acceptance or constructive approval requirements do not apply if there is a disagreement over quantity, quality, or Contractor compliance with a contract provision. These requirements also do not compel Government officials to accept work or services, approve Contractor estimates, perform contract administration functions, or make payment prior to fulfilling their responsibilities.

(ii) The following periods of time will not be included in the determination of an interest penalty:

(A) The period taken to notify the Contractor of defects in invoices submitted to the Government, but this may not exceed 7 days.

(B) The period between the defects notice and resubmission of the corrected invoice by the Contractor.

(C) For incorrect electronic funds transfer (EFT) information, in accordance with the EFT clause of this contract.

(iii) Interest penalties will not continue to accrue after the filing of a claim for such penalties under the clause at 52.233-1, Disputes, or for more than 1 year. Interest penalties of less than \$1 need not be paid.

(iv) Interest penalties are not required on payment delays due to disagreement between the Government and the Contractor over the payment amount or other issues involving contract compliance, or on amounts temporarily withheld or retained in accordance with the terms of the contract. Claims involving disputes, and any interest that may be payable, will be resolved in accordance with the clause at 52.233-1, Disputes.

(5) Prompt payment discounts. An interest penalty also shall be paid automatically by the designated payment office, without request from the Contractor, if a discount for prompt payment is taken improperly. The interest penalty will be calculated on the amount of discount taken for the period beginning with the first day after the end of the discount period through the date when the Contractor is paid.

(6) Additional interest penalty.

(i) A penalty amount, calculated in accordance with subdivision (a)(6)(iii) of this clause, shall be paid in addition to the interest penalty amount if the Contractor--

(A) Is owed an interest penalty of \$1 or more;

(B) Is not paid the interest penalty within 10 days after the date the invoice amount is paid; and

(C) Makes a written demand to the designated payment office for additional penalty payment, in accordance with subdivision (a)(6)(ii) of this clause, postmarked not later than 40 days after the date the invoice amount is paid.

(ii)(A) Contractors shall support written demands for additional penalty payments with the following data. No additional data shall be required. Contractors shall--

(1) Specifically assert that late payment interest is due under a specific invoice, and request payment of all overdue late payment interest penalty and such additional penalty as may be required;

(2) Attach a copy of the invoice on which the unpaid late payment interest was due; and

(3) State that payment of the principal has been received,

including the date of receipt.

(B) Demands must be postmarked on or before the 40th day after payment was made, except that--

(1) If the postmark is illegible or nonexistent, the demand must have been received and annotated with the date of receipt by the designated payment office on or before the 40th day after payment was made; or

(2) If the postmark is illegible or nonexistent and the designated payment office fails to make the required annotation, the demand's validity will be determined by the date the Contractor has placed on the demand; provided such date is no later than the 40th day after payment was made.

(iii)(A) The additional penalty shall be equal to 100 percent of any original late payment interest penalty, except--

(1) The additional penalty shall not exceed \$5,000;

(2) The additional penalty shall never be less than \$25; and

(3) No additional penalty is owed if the amount of the underlying interest penalty is less than \$1.

(B) If the interest penalty ceases to accrue in accordance with the limits stated in subdivision (a)(4)(iii) of this clause, the amount of the additional penalty shall be calculated on the amount of interest penalty that would have accrued in the absence of these limits, subject to the overall limits on the additional penalty specified in subdivision (a)(6)(iii)(A) of this clause.

(C) For determining the maximum and minimum additional penalties, the test shall be the interest penalty due on each separate payment made for each separate contract. The maximum and minimum additional penalty shall not be based upon individual invoices unless the invoices are paid separately. Where payments are consolidated for disbursing purposes, the maximum and minimum additional penalty determination shall be made separately for each contract therein.

(D) The additional penalty does not apply to payments regulated by other Government regulations (e.g., payments under utility contracts subject to tariffs and regulation).

(b) Contract financing payments--

(1) Due dates for recurring financing payments. If this contract provides for contract financing, requests for payment shall be submitted to the designated billing office as specified in this contract or as directed by the Contracting Officer. Contract financing payments shall be made on the 30th day after receipt of a proper contract financing request by the designated billing office. In the event that an audit or other review of a specific financing request is required to ensure compliance with the terms and conditions of the contract, the designated payment office is not compelled to make payment by the due date specified.

(2) Due dates for other contract financing. For advance payments, loans, or other arrangements that do not involve recurring submissions of contract financing requests, payment shall be made in accordance with the corresponding contract terms or as directed by the Contracting Officer.

(3) Interest penalty not applicable. Contract financing payments shall not be assessed an interest penalty for payment delays.

(c) Subcontract clause requirements. The Contractor shall include in

each subcontract for property or services (including a material supplier) for the purpose of performing this contract the following:

(1) Prompt payment for subcontractors. A payment clause that obligates the Contractor to pay the subcontractor for satisfactory performance under its subcontract not later than 7 days from receipt of payment out of such amounts as are paid to the Contractor under this contract.

(2) Interest for subcontractors. An interest penalty clause that obligates the Contractor to pay to the subcontractor an interest penalty for each payment not made in accordance with the payment clause--

(i) For the period beginning on the day after the required payment date and ending on the date on which payment of the amount due is made; and

(ii) Computed at the rate of interest established by the Secretary of the Treasury, and published in the Federal Register, for interest payments under section 12 of the Contract Disputes Act of 1978 (41 U.S.C. 611) in effect at the time the Contractor accrues the obligation to pay an interest penalty.

(3) Subcontractor clause flowdown. A clause requiring each subcontractor to include a payment clause and an interest penalty clause conforming to the standards set forth in subparagraphs (c)(1) and (c)(2) of this clause in each of its subcontracts, and to require each of its subcontractors to include such clauses in their subcontracts with each lower-tier subcontractor or supplier.

(d) Subcontract clause interpretation. The clauses required by paragraph (c) of this clause shall not be construed to impair the right of the Contractor or a subcontractor at any tier to negotiate, and to include in their subcontract, provisions that--

(1) Retainage permitted. Permit the Contractor or a subcontractor to retain (without cause) a specified percentage of each progress payment otherwise due to a subcontractor for satisfactory performance under the subcontract without incurring any obligation to pay a late payment interest penalty, in accordance with terms and conditions agreed to by the parties to the subcontract, giving such recognition as the parties deem appropriate to the ability of a subcontractor to furnish a performance bond and a payment bond;

(2) Withholding permitted. Permit the Contractor or subcontractor to make a determination that part or all of the subcontractor's request for payment may be withheld in accordance with the subcontract agreement; and

(3) Withholding requirements. Permit such withholding without incurring any obligation to pay a late payment penalty if--

(i) A notice conforming to the standards of paragraph (g) of this clause previously has been furnished to the subcontractor; and

(ii) A copy of any notice issued by a Contractor pursuant to subdivision (d)(3)(i) of this clause has been furnished to the Contracting Officer.

(e) Subcontractor withholding procedures. If a Contractor, after making a request for payment to the Government but before making a payment to a subcontractor for the subcontractor's performance covered by the payment request, discovers that all or a portion of the payment otherwise due such subcontractor is subject to withholding from the subcontractor in accordance with the subcontract agreement, then the Contractor shall--

(1) Subcontractor notice. Furnish to the subcontractor a notice

conforming to the standards of paragraph (g) of this clause as soon as practicable upon ascertaining the cause giving rise to a withholding, but prior to the due date for subcontractor payment;

(2) Contracting Officer notice. Furnish to the Contracting Officer, as soon as practicable, a copy of the notice furnished to the subcontractor pursuant to subparagraph (e)(1) of this clause;

(3) Subcontractor progress payment reduction. Reduce the subcontractor's progress payment by an amount not to exceed the amount specified in the notice of withholding furnished under subparagraph (e)(1) of this clause;

(4) Subsequent subcontractor payment. Pay the subcontractor as soon as practicable after the correction of the identified subcontract performance deficiency, and--

(i) Make such payment within--

(A) Seven days after correction of the identified subcontract performance deficiency (unless the funds therefor must be recovered from the Government because of a reduction under paragraph (e)(5)(i)) of this clause; or

(B) Seven days after the Contractor recovers such funds from the Government; or

(ii) Incur an obligation to pay a late payment interest penalty computed at the rate of interest established by the Secretary of the Treasury, and published in the Federal Register, for interest payments under section 12 of the Contracts Disputes Act of 1978 (41 U.S.C. 611) in effect at the time the Contractor accrues the obligation to pay an interest penalty;

(5) Notice to Contracting Officer. Notify the Contracting Officer upon--

(i) Reduction of the amount of any subsequent certified application for payment; or

(ii) Payment to the subcontractor of any withheld amounts of a progress payment, specifying--

(A) The amounts withheld under subparagraph (e)(1) of this clause; and

(B) The dates that such withholding began and ended; and

(6) Interest to Government. Be obligated to pay to the Government an amount equal to interest on the withheld payments (computed in the manner provided in 31 U.S.C. 3903(c)(1)), from the 8th day after receipt of the withheld amounts from the Government until--

(i) The day the identified subcontractor performance deficiency is corrected; or

(ii) The date that any subsequent payment is reduced under subdivision (e)(5)(i) of this clause.

(f) Third-party deficiency reports--

(1) Withholding from subcontractor. If a Contractor, after making payment to a first-tier subcontractor, receives from a supplier or subcontractor of the first-tier subcontractor (hereafter referred to as a "second-tier subcontractor") a written notice in accordance with section 2 of the Act of August 24, 1935 (40 U.S.C. 270b, Miller Act), asserting a deficiency in such first-tier subcontractor's performance under the contract for which the Contractor may be ultimately liable, and the Contractor determines that all or a portion of future payments otherwise

due such first-tier subcontractor is subject to withholding in accordance with the subcontract agreement, the Contractor may, without incurring an obligation to pay an interest penalty under subparagraph (e)(6) of this clause--

(i) Furnish to the first-tier subcontractor a notice conforming to the standards of paragraph (g) of this clause as soon as practicable upon making such determination; and

(ii) Withhold from the first-tier subcontractor's next available progress payment or payments an amount not to exceed the amount specified in the notice of withholding furnished under paragraph (f)(1)(i) of this clause.

(2) Subsequent payment or interest charge. As soon as practicable, but not later than 7 days after receipt of satisfactory written notification that the identified subcontract performance deficiency has been corrected, the Contractor shall--

(i) Pay the amount withheld under paragraph (f)(1)(ii) of this clause to such first-tier subcontractor; or

(ii) Incur an obligation to pay a late payment interest penalty to such first-tier subcontractor computed at the rate of interest established by the Secretary of the Treasury, and published in the Federal Register, for interest payments under section 12 of the Contracts Disputes Act of 1978 (41 U.S.C. 611) in effect at the time the Contractor accrues the obligation to pay an interest penalty.

(g) Written notice of subcontractor withholding. A written notice of any withholding shall be issued to a subcontractor (with a copy to the Contracting Officer of any such notice issued by the Contractor), specifying--

(1) The amount to be withheld;

(2) The specific causes for the withholding under the terms of the subcontract; and

(3) The remedial actions to be taken by the subcontractor in order to receive payment of the amounts withheld.

(h) Subcontractor payment entitlement. The Contractor may not request payment from the Government of any amount withheld or retained in accordance with paragraph (d) of this clause until such time as the Contractor has determined and certified to the Contracting Officer that the subcontractor is entitled to the payment of such amount.

(i) Prime-subcontractor disputes. A dispute between the Contractor and subcontractor relating to the amount or entitlement of a subcontractor to a payment or a late payment interest penalty under a clause included in the subcontract pursuant to paragraph (c) of this clause does not constitute a dispute to which the United States is a party. The United States may not be interpleaded in any judicial or administrative proceeding involving such a dispute.

(j) Preservation of prime-subcontractor rights. Except as provided in paragraph (i) of this clause, this clause shall not limit or impair any contractual, administrative, or judicial remedies otherwise available to the Contractor or a subcontractor in the event of a dispute involving late payment or nonpayment by the Contractor or deficient subcontract performance or nonperformance by a subcontractor.

(k) Non-recourse for prime contractor interest penalty. The Contractor's obligation to pay an interest penalty to a subcontractor pursuant to the

clauses included in a subcontract under paragraph (c) of this clause shall not be construed to be an obligation of the United States for such interest penalty. A cost-reimbursement claim may not include any amount for reimbursement of such interest penalty.

(End of clause)

59 52. 232- 34 OPTIONAL INFORMATION FOR ELECTRONIC FUNDS TRANSFER PAYMENT  
(AUG 1996)

(a) Method of payment.

(1) Except as provided in paragraph (a)(2) of this clause, after the Contractor provides the information described in paragraph (d) of this clause, in accordance with paragraph (b) of this clause, payments by the Government under this contract, including invoice and contract financing payments, may be made by check or electronic funds transfer (EFT) at the option of the Government. If payment is made by EFT, the Government may, at its option, also forward the associated payment information by electronic transfer. As used in this clause, the term "EFT" refers to the funds transfer and may also include the information transfer.

(2) Notwithstanding the provision of this clause making the furnishing of EFT information optional, the Contractor shall furnish the EFT information described in paragraph (d) for any payment to be made after January 1, 1999.

(b) Contractor consent.

(1) If the Contractor is willing to be paid by EFT, the Contractor shall provide the EFT information described in paragraph (d) of this clause. The Contractor agrees that, after providing EFT information in accordance with this clause, the Contractor cannot withdraw the Government's right to make payment by EFT for this contract.

(2) If the Contractor provides EFT information applicable to multiple contracts, the Contractor shall specifically state the applicability of this EFT information in terms acceptable to the payment office.

(c) Contractor's EFT information. Prior to submission of the first request for payment (whether for invoice or contract financing payment) under this contract, for which the Contractor desires EFT payment, the Contractor shall provide the information required to make contract payment by EFT, as described in paragraph (d) of this clause, directly to the Government payment office named in this contract. If more than one payment office is named for the contract, the Contractor shall provide a separate notice to each office. In the event that the EFT information changes, the Contractor shall be responsible for providing the changed information to the designated payment office(s).

(d) Required EFT information. The Government may make payment by EFT through either an Automated Clearing House (ACH) subject to the domestic banking laws of the United States or the Federal Reserve Wire Transfer System at the Government's option. The Contractor shall provide the following information for both methods in a form acceptable to the designated payment office. The Contractor may supply this data for this or multiple contracts (see paragraph (b) of this clause).

(1) The contract number to which this notice applies.

(2) The Contractor's name and remittance address, as stated in the

contract, and account number at the Contractor's financial agent.

(3) The signature (manual or electronic, as appropriate), title, and telephone number of the Contractor official authorized to provide this information.

(4) For ACH payment only:

(i) Name, address, and 9-digit Routing Transit Number of the Contractor's financial agent.

(ii) Contractor's account number and the type of account (checking, saving, or lockbox).

(5) For Federal Reserve Wire Transfer System payments only:

(i) Name, address, telegraphic abbreviation, and the 9-digit Routing Transit Number for the Contractor's financial agent.

(ii) If the Contractor's financial agent is not directly on-line to the Federal Reserve Wire Transfer System and, therefore, not the receiver of the wire transfer payment, the Contractor shall also provide the name, address, and 9-digit Routing Transit Number of the correspondent financial institution receiving the wire transfer payment.

(e) Suspension of payment.

(1) Notwithstanding the provisions of any other clause of this contract, if, after receipt of the Contractor's EFT information in accordance with paragraph (b) of this clause, the EFT information is found to be incorrect, or, for payment after January 1, 1999, if EFT information has not been furnished, then until receipt by the designated payment office of the correct EFT information from the Contractor, (i) the Government is not required to make any further payment under this contract; and (ii) any invoice or contract financing request shall be deemed not to be a valid invoice or contract financing request as defined in the Prompt Payment clause of this contract.

(2) If the EFT information changes after submission of correct EFT information, the Government shall begin using the changed EFT information no later than the 30th day after its receipt to the extent payment is made by EFT. However, the Contractor may request that no further payments be made until the changed EFT information is implemented by the payment office. If such suspension would result in a late payment under the Prompt Payment clause of this contract, the Contractor's request for suspension shall extend the due date for payment by the number of days of the suspension.

(f) Contractor EFT arrangements. The Contractor shall designate a single financial agent capable of receiving and processing the electronic funds transfer using the EFT methods described in paragraph (d) of this clause. The Contractor shall pay all fees and charges for receipt and processing of transfers.

(g) Liability for uncompleted or erroneous transfers.

(1) If an uncompleted or erroneous transfer occurs because the Government failed to use the Contractor-provided EFT information in the correct manner, the Government remains responsible for (i) making a correct payment, (ii) paying any prompt payment penalty due, and (iii) recovering any erroneously directed funds.

(2) If an uncompleted or erroneous transfer occurs because Contractor-provided EFT information was incorrect at the time of Government release of the EFT payment transaction instruction to the



Federal Reserve System, and--

(i) If the funds are no longer under the control of the payment office, the Government is deemed to have made payment and the Contractor is responsible for recovery of any erroneously directed funds; or

(ii) If the funds remain under the control of the payment office, the Government retains the right to either make payment by mail or suspend the payment in accordance with paragraph (e) of this clause.

(h) EFT and prompt payment.

(1) A payment shall be deemed to have been made in a timely manner in accordance with the Prompt Payment clause of this contract if, in the EFT payment transaction instruction given to the Federal Reserve System, the date specified for settlement of the payment is on or before the prompt payment due date, provided the specified payment date is a valid date under the rules of the Federal Reserve System.

(2) When payment cannot be made by EFT because of incorrect EFT information provided by the Contractor, no interest penalty is due after the date of the uncompleted or erroneous payment transaction, provided that notice of the defective EFT information is issued to the Contractor within 7 days after the Government is notified of the defective EFT information.

(i) EFT and assignment of claims. If the Contractor assigns the proceeds of this contract as provided for in the Assignment of Claims clause of this contract, the assignee shall provide the assignee EFT information required by paragraph (d) of this clause. In all respects, the requirements of this clause shall apply to the assignee as if it were the Contractor. EFT information which shows the ultimate recipient of the transfer to be other than the Contractor, in the absence of a proper assignment of claims acceptable to the Government, is incorrect EFT information within the meaning of paragraph (e) of this clause.

(j) Payment office discretion. If, after submitting the EFT information, the Contractor does not wish to receive payment by EFT methods for one or more payments, the Contractor may submit a request to the designated payment office to refrain from using the EFT payment method. The decision to grant the request is solely that of the Government.

(k) Change of EFT information by financial agent. The Contractor agrees that the Contractor's financial agent may notify the Government of a change to the routing transit number, Contractor account number, or account type. The Government shall use the changed data in accordance with paragraph (e)(2) of this clause. The Contractor agrees that the information provided by the agent is deemed to be correct information as if it were provided by the Contractor. The Contractor agrees that the agent's notice of changed EFT data is deemed to be a request by the Contractor in accordance with paragraph (e)(2) that no further payments be made until the changed EFT information is implemented by the payment office.

(End of clause)

60 52.233-1 DISPUTES (OCT 1995)

(a) This contract is subject to the Contract Disputes Act of 1978, as amended (41 U. S. C. 601-613).

(b) Except as provided in the Act, all disputes arising under or relating to this contract shall be resolved under this clause.

(c) "Claim," as used in this clause, means a written demand or written assertion by one of the contracting parties seeking, as a matter of right, the payment of money in a sum certain, the adjustment or interpretation of contract terms, or other relief arising under or relating to this contract. A claim arising under a contract, unlike a claim relating to that contract, is a claim that can be resolved under a contract clause that provides for the relief sought by the claimant. However, a written demand or written assertion by the Contractor seeking the payment of money exceeding \$100,000 is not a claim under the Act until certified as required by subparagraph (d)(2) of this clause. A voucher, invoice, or other routine request for payment that is not in dispute when submitted is not a claim under the Act. The submission may be converted to a claim under the Act, by complying with the submission and certification requirements of this clause, if it is disputed either as to liability or amount or is not acted upon in a reasonable time.

(d)(1) A claim by the Contractor shall be made in writing and, unless otherwise stated in this contract, submitted within 6 years after accrual of the claim to the Contracting Officer for a written decision. A claim by the Government against the Contractor shall be subject to a written decision by the Contracting Officer.

(2)(i) Contractors shall provide the certification specified in subparagraph (d)(2)(iii) of this clause when submitting any claim -

(A) Exceeding \$100,000; or

(B) Regardless of the amount claimed, when using -

(1) Arbitration conducted pursuant to 5 U.S.C. 575-580; or

(2) Any other alternative means of dispute resolution (ADR) technique that the agency elects to handle in accordance with the Administrative Dispute Resolution Act (ADRA).

(ii) The certification requirement does not apply to issues in controversy that have not been submitted as all or part of a claim

(iii) The certification shall state as follows:

"I certify that the claim is made in good faith; that the supporting data are accurate and complete to the best of my knowledge and belief; that the amount requested accurately reflects the contract adjustment for which the Contractor believes the Government is liable; and that I am duly authorized to certify the claim on behalf of the Contractor."

(3) The certification may be executed by any person duly authorized to bind the Contractor with respect to the claim

(e) For Contractor claims of \$100,000 or less, the Contracting Officer must, if requested in writing by the Contractor, render a decision within 60 days of the request. For Contractor-certified claims over \$100,000, the Contracting Officer must, within 60 days, decide the claim or notify the Contractor of the date by which the decision will be made.

(f) The Contracting Officer's decision shall be final unless the Contractor appeals or files a suit as provided in the Act.

(g) If the claim by the Contractor is submitted to the Contracting Officer or a claim by the Government is presented to the Contractor, the parties, by mutual consent, may agree to use ADR. If the Contractor refuses an offer for alternative disputes resolution, the Contractor shall inform the Contracting Officer, in writing, of the Contractor's specific

reasons for rejecting the request. When using arbitration conducted pursuant to 5 U.S.C. 575-580, or when using any other ADR technique that the agency elects to handle in accordance with the ADRA, any claim, regardless of amount, shall be accompanied by the certification described in subparagraph (d)(2)(iii) of this clause, and executed in accordance with subparagraph (d)(3) of this clause.

(h) The Government shall pay interest on the amount found due and unpaid from (1) the date that the Contracting Officer receives the claim (certified, if required); or (2) the date that payment otherwise would be due, if that date is later, until the date of payment. With regard to claims having defective certifications, as defined in (FAR) 48 CFR 33.201, interest shall be paid from the date that the Contracting Officer initially receives the claim. Simple interest on claims shall be paid at the rate, fixed by the Secretary of the Treasury as provided in the Act, which is applicable to the period during which the Contracting Officer receives the claim and then at the rate applicable for each 6-month period as fixed by the Treasury Secretary during the pendency of the claim.

(i) The Contractor shall proceed diligently with performance of this contract, pending final resolution of any request for relief, claim, appeal, or action arising under the contract, and comply with any decision of the Contracting Officer.

(End of clause)

61 52.233-3 PROTEST AFTER AWARD (AUG 1996)

(a) Upon receipt of a notice of protest (as defined in FAR 33.101) or a determination that a protest is likely (see FAR 33.102(d)), the Contracting Officer may, by written order to the Contractor, direct the Contractor to stop performance of the work called for by this contract. The order shall be specifically identified as a stop-work order issued under this clause. Upon receipt of the order, the Contractor shall immediately comply with its terms and take all reasonable steps to minimize the incurrence of costs allocable to the work covered by the order during the period of work stoppage. Upon receipt of the final decision in the protest, the Contracting Officer shall either--

- (1) Cancel the stop-work order; or
- (2) Terminate the work covered by the order as provided in the Default, or the Termination for Convenience of the Government, clause of this contract.

(b) If a stop-work order issued under this clause is canceled either before or after a final decision in the protest, the Contractor shall resume work. The Contracting Officer shall make an equitable adjustment in the delivery schedule or contract price, or both, and the contract shall be modified, in writing, accordingly, if--

- (1) The stop-work order results in an increase in the time required for, or in the Contractor's cost properly allocable to, the performance of any part of this contract; and
- (2) The Contractor asserts its right to an adjustment within 30 days after the end of the period of work stoppage; provided, that if the Contracting Officer decides the facts justify the action, the Contracting Officer may receive and act upon a proposal at any time before final

payment under this contract.

(c) If a stop-work order is not canceled and the work covered by the order is terminated for the convenience of the Government, the Contracting Officer shall allow reasonable costs resulting from the stop-work order in arriving at the termination settlement.

(d) If a stop-work order is not canceled and the work covered by the order is terminated for default, the Contracting Officer shall allow, by equitable adjustment or otherwise, reasonable costs resulting from the stop-work order.

(e) The Government's rights to terminate this contract at any time are not affected by action taken under this clause.

(f) If, as the result of the Contractor's intentional or negligent misstatement, misrepresentation, or miscertification, a protest related to this contract is sustained, and the Government pays costs, as provided in FAR 33.102(b)(2) or 33.104(h)(1), the Government may require the Contractor to reimburse the Government the amount of such costs. In addition to any other remedy available, and pursuant to the requirements of Subpart 32.6, the Government may collect this debt by offsetting the amount against any payment due the Contractor under any contract between the Contractor and the Government.

(End of clause)

62 52.236-2 DIFFERING SITE CONDITIONS (APR 1984)

(a) The Contractor shall promptly, and before the conditions are disturbed, give a written notice to the Contracting Officer of (1) subsurface or latent physical conditions at the site which differ materially from those indicated in this contract, or (2) unknown physical conditions at the site, of an unusual nature, which differ materially from those ordinarily encountered and generally recognized as inhering in work of the character provided for in the contract.

(b) The Contracting Officer shall investigate the site conditions promptly after receiving the notice. If the conditions do materially so differ and cause an increase or decrease in the Contractor's cost of, or the time required for, performing any part of the work under this contract, whether or not changed as a result of the conditions, an equitable adjustment shall be made under this clause and the contract modified in writing accordingly.

(c) No request by the Contractor for an equitable adjustment to the contract under this clause shall be allowed, unless the Contractor has given the written notice required; provided, that the time prescribed in (a) above for giving written notice may be extended by the Contracting Officer.

(d) No request by the Contractor for an equitable adjustment to the contract for differing site conditions shall be allowed if made after final payment under this contract.

(End of clause)

(a) The Contractor acknowledges that it has taken steps reasonably necessary to ascertain the nature and location of the work, and that it has investigated and satisfied itself as to the general and local conditions which can affect the work or its cost, including but not limited to (1) conditions bearing upon transportation, disposal, handling, and storage of materials; (2) the availability of labor, water, electric power, and roads; (3) uncertainties of weather, river stages, tides, or similar physical conditions at the site; (4) the conformation and conditions of the ground; and (5) the character of equipment and facilities needed preliminary to and during work performance. The Contractor also acknowledges that it has satisfied itself as to the character, quality, and quantity of surface and subsurface materials or obstacles to be encountered insofar as this information is reasonably ascertainable from an inspection of the site, including all exploratory work done by the Government, as well as from the drawings and specifications made a part of this contract. Any failure of the Contractor to take the actions described and acknowledged in this paragraph will not relieve the Contractor from responsibility for estimating properly the difficulty and cost of successfully performing the work, or for proceeding to successfully perform the work without additional expense to the Government.

(b) The Government assumes no responsibility for any conclusions or interpretations made by the Contractor based on the information made available by the Government. Nor does the Government assume responsibility for any understanding reached or representation made concerning conditions which can affect the work by any of its officers or agents before the execution of this contract, unless that understanding or representation is expressly stated in this contract.

(End of clause)

(a) All equipment, material, and articles incorporated into the work covered by this contract shall be new and of the most suitable grade for the purpose intended, unless otherwise specifically provided in this contract. References in the specifications to equipment, material, articles, or patented processes by trade name, make, or catalog number, shall be regarded as establishing a standard of quality and shall not be construed as limiting competition. The Contractor may, at its option, use any equipment, material, article, or process that, in the judgment of the Contracting Officer, is equal to that named in the specifications, unless otherwise specifically provided in this contract.

(b) The Contractor shall obtain the Contracting Officer's approval of the machinery and mechanical and other equipment to be incorporated into the work. When requesting approval, the Contractor shall furnish to the Contracting Officer the name of the manufacturer, the model number, and other information concerning the performance, capacity, nature, and rating of the machinery and mechanical and other equipment. When required by this contract or by the Contracting Officer, the Contractor shall also

obtain the Contracting Officer's approval of the material or articles which the Contractor contemplates incorporating into the work. When requesting approval, the Contractor shall provide full information concerning the material or articles. When directed to do so, the Contractor shall submit samples for approval at the Contractor's expense, with all shipping charges prepaid. Machinery, equipment, material, and articles that do not have the required approval shall be installed or used at the risk of subsequent rejection.

(c) All work under this contract shall be performed in a skillful and workmanlike manner. The Contracting Officer may require, in writing, that the Contractor remove from the work any employee the Contracting Officer deems incompetent, careless, or otherwise objectionable.

(End of clause)

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65    52.236-6            SUPERINTENDENCE BY THE CONTRACTOR (APR 1984)

At all times during performance of this contract and until the work is completed and accepted, the Contractor shall directly superintend the work or assign and have on the work site a competent superintendent who is satisfactory to the Contracting Officer and has authority to act for the Contractor.

(End of clause)

66    52.236-7            PERMITS AND RESPONSIBILITIES (NOV 1991)

The Contractor shall, without additional expense to the Government, be responsible for obtaining any necessary licenses and permits, and for complying with any Federal, State, and municipal laws, codes, and regulations applicable to the performance of the work. The Contractor shall also be responsible for all damages to persons or property that occur as a result of the Contractor's fault or negligence. The Contractor shall also be responsible for all materials delivered and work performed until completion and acceptance of the entire work, except for any completed unit of work which may have been accepted under the contract.

(End of clause)

67    52.236-8            OTHER CONTRACTS (APR 1984)

The Government may undertake or award other contracts for additional work at or near the site of the work under this contract. The Contractor shall fully cooperate with the other contractors and with Government employees and shall carefully adapt scheduling and performing the work under this contract to accommodate the additional work, heeding any direction that may be provided by the Contracting Officer. The Contractor shall not commit or permit any act that will interfere with the performance of work by any other contractor or by Government employees.

(End of clause)

PROTECTION OF EXISTING VEGETATION, STRUCTURES, EQUIPMENT,  
UTILITIES, AND IMPROVEMENTS (APR 1984)

(a) The Contractor shall preserve and protect all structures, equipment, and vegetation (such as trees, shrubs, and grass) on or adjacent to the work site, which are not to be removed and which do not unreasonably interfere with the work required under this contract. The Contractor shall only remove trees when specifically authorized to do so, and shall avoid damaging vegetation that will remain in place. If any limbs or branches of trees are broken during contract performance, or by the careless operation of equipment, or by workmen, the Contractor shall trim those limbs or branches with a clean cut and paint the cut with a tree-pruning compound as directed by the Contracting Officer.

(b) The Contractor shall protect from damage all existing improvements and utilities (1) at or near the work site, and (2) on adjacent property of a third party, the locations of which are made known to or should be known by the Contractor. The Contractor shall repair any damage to those facilities, including those that are the property of a third party, resulting from failure to comply with the requirements of this contract or failure to exercise reasonable care in performing the work. If the Contractor fails or refuses to repair the damage promptly, the Contracting Officer may have the necessary work performed and charge the cost to the Contractor.

(End of clause)

## OPERATIONS AND STORAGE AREAS (APR 1984)

(a) The Contractor shall confine all operations (including storage of materials) on Government premises to areas authorized or approved by the Contracting Officer. The Contractor shall hold and save the Government, its officers and agents, free and harmless from liability of any nature occasioned by the Contractor's performance.

(b) Temporary buildings (e.g., storage sheds, shops, offices) and utilities may be erected by the Contractor only with the approval of the Contracting Officer and shall be built with labor and materials furnished by the Contractor without expense to the Government. The temporary buildings and utilities shall remain the property of the Contractor and shall be removed by the Contractor at its expense upon completion of the work. With the written consent of the Contracting Officer, the buildings and utilities may be abandoned and need not be removed.

(c) The Contractor shall, under regulations prescribed by the Contracting Officer, use only established roadways, or use temporary roadways constructed by the Contractor when and as authorized by the Contracting Officer. When materials are transported in prosecuting the work, vehicles shall not be loaded beyond the loading capacity recommended by the manufacturer of the vehicle or prescribed by any Federal, State, or local law or regulation. When it is necessary to cross curbs or sidewalks, the Contractor shall protect them from damage. The Contractor shall repair or pay for the repair of any damaged curbs, sidewalks, or roads.

(End of clause)

70 52. 236-11 USE AND POSSESSION PRIOR TO COMPLETION (APR 1984)

(a) The Government shall have the right to take possession of or use any completed or partially completed part of the work. Before taking possession of or using any work, the Contracting Officer shall furnish the Contractor a list of items of work remaining to be performed or corrected on those portions of the work that the Government intends to take possession of or use. However, failure of the Contracting Officer to list any item of work shall not relieve the Contractor of responsibility for complying with the terms of the contract. The Government's possession or use shall not be deemed an acceptance of any work under the contract.

(b) While the Government has such possession or use, the Contractor shall be relieved of the responsibility for the loss of or damage to the work resulting from the Government's possession or use, notwithstanding the terms of the clause in this contract entitled "Permits and Responsibilities." If prior possession or use by the Government delays the progress of the work or causes additional expense to the Contractor, an equitable adjustment shall be made in the contract price or the time of completion, and the contract shall be modified in writing accordingly.

(End of clause)

71 52. 236-12 CLEANING UP (APR 1984)

The Contractor shall at all times keep the work area, including storage areas, free from accumulations of waste materials. Before completing the work, the Contractor shall remove from the work and premises any rubbish, tools, scaffolding, equipment, and materials that are not the property of the Government. Upon completing the work, the Contractor shall leave the work area in a clean, neat, and orderly condition satisfactory to the Contracting Officer.

(End of clause)

72 52. 236-13 I ACCIDENT PREVENTION (NOV 1991) -- ALTERNATE I (NOV 1991)

(a) The Contractor shall provide and maintain work environments and procedures which will (1) safeguard the public and Government personnel, property, materials, supplies, and equipment exposed to Contractor operations and activities; (2) avoid interruptions of Government operations and delays in project completion dates; and (3) control costs in the performance of this contract.

(b) For these purposes on contracts for construction or dismantling, demolition, or removal of improvements, the Contractor shall--

(1) Provide appropriate safety barricades, signs, and signal lights;

(2) Comply with the standards issued by the Secretary of Labor at 29 CFR Part 1926 and 29 CFR Part 1910; and

(3) Ensure that any additional measures the Contracting Officer determines to be reasonably necessary for the purposes are taken.

(c) If this contract is for construction or dismantling, demolition or removal of improvements with any Department of Defense agency or



component, the Contractor shall comply with all pertinent provisions of the latest version of U. S. Army Corps of Engineers Safety and Health Requirements Manual, EM 385-1-1, in effect on the date of the solicitation.

(d) Whenever the Contracting Officer becomes aware of any noncompliance with these requirements or any condition which poses a serious or imminent danger to the health or safety of the public or Government personnel, the Contracting Officer shall notify the Contractor orally, with written confirmation, and request immediate initiation of corrective action. This notice, when delivered to the Contractor or the Contractor's representative at the work site, shall be deemed sufficient notice of the noncompliance and that corrective action is required. After receiving the notice, the Contractor shall immediately take corrective action. If the Contractor fails or refuses to promptly take corrective action, the Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. The Contractor shall not be entitled to any equitable adjustment of the contract price or extension of the performance schedule on any stop work order issued under this clause.

(e) The Contractor shall insert this clause, including this paragraph (e), with appropriate changes in the designation of the parties, in subcontracts.

(f) Before commencing the work, the Contractor shall--

(1) Submit a written proposed plan for implementing this clause. The plan shall include an analysis of the significant hazards to life, limb, and property inherent in contract work performance and a plan for controlling these hazards; and

(2) Meet with representatives of the Contracting Officer to discuss and develop a mutual understanding relative to administration of the overall safety program

(End of clause)

73 52.236-15 SCHEDULES FOR CONSTRUCTION CONTRACTS (APR 1984)

(a) The Contractor shall, within five days after the work commences on the contract or another period of time determined by the Contracting Officer, prepare and submit to the Contracting Officer for approval three copies of a practicable schedule showing the order in which the Contractor proposes to perform the work, and the dates on which the Contractor contemplates starting and completing the several salient features of the work (including acquiring materials, plant, and equipment). The schedule shall be in the form of a progress chart of suitable scale to indicate appropriately the percentage of work scheduled for completion by any given date during the period. If the Contractor fails to submit a schedule within the time prescribed, the Contracting Officer may withhold approval of progress payments until the Contractor submits the required schedule.

(b) The Contractor shall enter the actual progress on the chart as directed by the Contracting Officer, and upon doing so shall immediately deliver three copies of the annotated schedule to the Contracting Officer. If, in the opinion of the Contracting Officer, the Contractor falls behind the approved schedule, the Contractor shall take steps necessary to improve its progress, including those that may be required by the Contracting

Officer, without additional cost to the Government. In this circumstance, the Contracting Officer may require the Contractor to increase the number of shifts, overtime operations, days of work, and/or the amount of construction plant, and to submit for approval any supplementary schedule or schedules in chart form as the Contracting Officer deems necessary to demonstrate how the approved rate of progress will be regained.

(c) Failure of the Contractor to comply with the requirements of the Contracting Officer under this clause shall be grounds for a determination by the Contracting Officer that the Contractor is not prosecuting the work with sufficient diligence to ensure completion within the time specified in the contract. Upon making this determination, the Contracting Officer may terminate the Contractor's right to proceed with the work, or any separable part of it, in accordance with the default terms of this contract.

(End of clause)

74 52.236-21 SPECIFICATIONS AND DRAWINGS FOR CONSTRUCTION (FEB 1997)

(a) The Contractor shall keep on the work site a copy of the drawings and specifications and shall at all times give the Contracting Officer access thereto. Anything mentioned in the specifications and not shown on the drawings, or shown on the drawings and not mentioned in the specifications, shall be of like effect as if shown or mentioned in both. In case of difference between drawings and specifications, the specifications shall govern. In case of discrepancy in the figures, in the drawings, or in the specifications, the matter shall be promptly submitted to the Contracting Officer, who shall promptly make a determination in writing. Any adjustment by the Contractor without such a determination shall be at its own risk and expense. The Contracting Officer shall furnish from time to time such detailed drawings and other information as considered necessary, unless otherwise provided.

(b) Wherever in the specifications or upon the drawings the words "directed", "required", "ordered", "designated", "prescribed", or words of like import are used, it shall be understood that the "direction", "requirement", "order", "designation", or "prescription", of the Contracting Officer is intended and similarly the words "approved", "acceptable", "satisfactory", or words of like import shall mean "approved by", or "acceptable to", or "satisfactory to" the Contracting Officer, unless otherwise expressly stated.

(c) Where "as shown", "as indicated", "as detailed", or words of similar import are used, it shall be understood that the reference is made to the drawings accompanying this contract unless stated otherwise. The word "provided" as used herein shall be understood to mean "provide complete in place," that is "furnished and installed".

(d) Shop drawings means drawings, submitted to the Government by the Contractor, subcontractor, or any lower tier subcontractor pursuant to a construction contract, showing in detail (1) the proposed fabrication and assembly of structural elements, and (2) the installation (i.e., fit, and attachment details) of materials or equipment. It includes drawings, diagrams, layouts, schematics, descriptive literature, illustrations, schedules, performance and test data, and similar materials furnished by the contractor to explain in detail specific portions of the work required

by the contract. The Government may duplicate, use, and disclose in any manner and for any purpose shop drawings delivered under this contract.

(e) If this contract requires shop drawings, the Contractor shall coordinate all such drawings, and review them for accuracy, completeness, and compliance with contract requirements and shall indicate its approval thereon as evidence of such coordination and review. Shop drawings submitted to the Contracting Officer without evidence of the Contractor's approval may be returned for resubmission. The Contracting Officer will indicate an approval or disapproval of the shop drawings and if not approved as submitted shall indicate the Government's reasons therefor. Any work done before such approval shall be at the Contractor's risk. Approval by the Contracting Officer shall not relieve the Contractor from responsibility for any errors or omissions in such drawings, nor from responsibility for complying with the requirements of this contract, except with respect to variations described and approved in accordance with (f) below.

(f) If shop drawings show variations from the contract requirements, the Contractor shall describe such variations in writing, separate from the drawings, at the time of submission. If the Contracting Officer approves any such variation, the Contracting Officer shall issue an appropriate contract modification, except that, if the variation is minor or does not involve a change in price or in time of performance, a modification need not be issued.

(g) The Contractor shall submit to the Contracting Officer for approval four copies (unless otherwise indicated) of all shop drawings as called for under the various headings of these specifications. Three sets (unless otherwise indicated) of all shop drawings, will be retained by the Contracting Officer and one set will be returned to the Contractor.

(End of clause)

75    52. 236- 26            PRECONSTRUCTION CONFERENCE (FEB 1995)

If the Contracting Officer decides to conduct a preconstruction conference, the successful offeror will be notified and will be required to attend. The Contracting Officer's notification will include specific details regarding the date, time, and location of the conference, any need for attendance by subcontractors, and information regarding the items to be discussed.

(End of clause)

76    52. 242- 13            BANKRUPTCY (JUL 1995)

In the event the Contractor enters into proceedings relating to bankruptcy, whether voluntary or involuntary, the Contractor agrees to furnish, by certified mail or electronic commerce method authorized by the contract, written notification of the bankruptcy to the Contracting Officer responsible for administering the contract. This notification shall be furnished within five days of the initiation of the proceedings relating to bankruptcy filing. This notification shall include the date on which the bankruptcy petition was filed, the identity of the court in which the

bankruptcy petition was filed, and a listing of Government contract numbers and contracting offices for all Government contracts against which final payment has not been made. This obligation remains in effect until final payment under this contract.

(End of clause)

77 52.242-14 SUSPENSION OF WORK (APR 1984)

(a) The Contracting Officer may order the Contractor, in writing, to suspend, delay, or interrupt all or any part of the work of this contract for the period of time that the Contracting Officer determines appropriate for the convenience of the Government.

(b) If the performance of all or any part of the work is, for an unreasonable period of time, suspended, delayed, or interrupted (1) by an act of the Contracting Officer in the administration of this contract, or (2) by the Contracting Officer's failure to act within the time specified in this contract (or within a reasonable time if not specified), an adjustment shall be made for any increase in the cost of performance of this contract (excluding profit) necessarily caused by the unreasonable suspension, delay, or interruption, and the contract modified in writing accordingly. However, no adjustment shall be made under this clause for any suspension, delay, or interruption to the extent that performance would have been so suspended, delayed, or interrupted by any other cause, including the fault or negligence of the Contractor, or for which an equitable adjustment is provided for or excluded under any other term or condition of this contract.

(c) A claim under this clause shall not be allowed (1) for any costs incurred more than 20 days before the Contractor shall have notified the Contracting Officer in writing of the act or failure to act involved (but this requirement shall not apply as to a claim resulting from a suspension order), and (2) unless the claim, in an amount stated, is asserted in writing as soon as practicable after the termination of the suspension, delay, or interruption, but not later than the date of final payment under the contract.

(End of clause)

78 52.243-4 CHANGES (AUG 1987)

(a) The Contracting Officer may, at any time, without notice to the sureties, if any, by written order designated or indicated to be a change order, make changes in the work within the general scope of the contract, including changes--

- (1) In the specifications (including drawings and designs);
- (2) In the method or manner of performance of the work;
- (3) In the Government-furnished facilities, equipment, materials, services, or site; or
- (4) Directing acceleration in the performance of the work.

(b) Any other written or oral order (which, as used in this paragraph (b), includes direction, instruction, interpretation, or determination) from the Contracting Officer that causes a change shall be treated as a

change order under this clause; provided, that the Contractor gives the Contracting Officer written notice stating (1) the date, circumstances, and source of the order and (2) that the Contractor regards the order as a change order.

(c) Except as provided in this clause, no order, statement, or conduct of the Contracting Officer shall be treated as a change under this clause or entitle the Contractor to an equitable adjustment.

(d) If any change under this clause causes an increase or decrease in the Contractor's cost of, or the time required for, the performance of any part of the work under this contract, whether or not changed by any such order, the Contracting Officer shall make an equitable adjustment and modify the contract in writing. However, except for an adjustment based on defective specifications, no adjustment for any change under paragraph (b) of this clause shall be made for any costs incurred more than 20 days before the Contractor gives written notice as required. In the case of defective specifications for which the Government is responsible, the equitable adjustment shall include any increased cost reasonably incurred by the Contractor in attempting to comply with the defective specifications.

(e) The Contractor must assert its right to an adjustment under this clause within 30 days after (1) receipt of a written change order under paragraph (a) of this clause or (2) the furnishing of a written notice under paragraph (b) of this clause, by submitting to the Contracting Officer a written statement describing the general nature and amount of the proposal, unless this period is extended by the Government. The statement of proposal for adjustment may be included in the notice under paragraph (b) above.

(f) No proposal by the Contractor for an equitable adjustment shall be allowed if asserted after final payment under this contract.

(End of clause)

79 52.244-2 SUBCONTRACTS (AUG 1998)

(a) Definitions. As used in this clause--

Approved purchasing system means a Contractor's purchasing system that has been reviewed and approved in accordance with Part 44 of the Federal Acquisition Regulation (FAR).

Consent to subcontract means the Contracting Officer's written consent for the Contractor to enter into a particular subcontract.

Subcontract means any contract, as defined in FAR Subpart 2.1, entered into by a subcontractor to furnish supplies or services for performance of the prime contract or a subcontract. It includes, but is not limited to, purchase orders, and changes and modifications to purchase orders.

(b) This clause does not apply to subcontracts for special test equipment when the contract contains the clause at FAR 52.245-18, Special Test Equipment.

(c) When this clause is included in a fixed-price type contract, consent to subcontract is required only on unpriced contract actions (including unpriced modifications or unpriced delivery orders), and only if required in accordance with paragraph (d) or (e) of this clause.

(d) If the Contractor does not have an approved purchasing system, consent to subcontract is required for any subcontract that--

(1) Is of the cost-reimbursement, time-and-materials, or labor-hour type; or

(2) Is fixed-price and exceeds--

(i) For a contract awarded by the Department of Defense, the Coast Guard, or the National Aeronautics and Space Administration, the greater of the simplified acquisition threshold or 5 percent of the total estimated cost of the contract; or

(ii) For a contract awarded by a civilian agency other than the Coast Guard and the National Aeronautics and Space Administration, either the simplified acquisition threshold or 5 percent of the total estimated cost of the contract.

(e) If the Contractor has an approved purchasing system, the Contractor nevertheless shall obtain the Contracting Officer's written consent before placing the following subcontracts:

(f)(1) The Contractor shall notify the Contracting Officer reasonably in advance of placing any subcontract or modification thereof for which consent is required under paragraph (c), (d), or (e) of this clause, including the following information:

(i) A description of the supplies or services to be subcontracted.

(ii) Identification of the type of subcontract to be used.

(iii) Identification of the proposed subcontractor.

(iv) The proposed subcontract price.

(v) The subcontractor's current, complete, and accurate cost or pricing data and Certificate of Current Cost or Pricing Data, if required by other contract provisions.

(vi) The subcontractor's Disclosure Statement or Certificate relating to Cost Accounting Standards when such data are required by other provisions of this contract.

(vii) A negotiation memorandum reflecting--

(A) The principal elements of the subcontract price negotiations;

(B) The most significant considerations controlling establishment of initial or revised prices;

(C) The reason cost or pricing data were or were not required;

(D) The extent, if any, to which the Contractor did not rely on the subcontractor's cost or pricing data in determining the price objective and in negotiating the final price;

(E) The extent to which it was recognized in the negotiation that the subcontractor's cost or pricing data were not accurate, complete, or current; the action taken by the Contractor and the subcontractor; and the effect of any such defective data on the total price negotiated;

(F) The reasons for any significant difference between the Contractor's price objective and the price negotiated; and

(G) A complete explanation of the incentive fee or profit plan when incentives are used. The explanation shall identify each critical performance element, management decisions used to

quantify each incentive element, reasons for the incentives, and a summary of all trade-off possibilities considered.

(2) The Contractor is not required to notify the Contracting Officer in advance of entering into any subcontract for which consent is not required under paragraph (c), (d), or (e) of this clause.

(g) Unless the consent or approval specifically provides otherwise, neither consent by the Contracting Officer to any subcontract nor approval of the Contractor's purchasing system shall constitute a determination--

(1) Of the acceptability of any subcontract terms or conditions;

(2) Of the allowability of any cost under this contract; or

(3) To relieve the Contractor of any responsibility for performing this contract.

(h) No subcontract or modification thereof placed under this contract shall provide for payment on a cost-plus-a-percentage-of-cost basis, and any fee payable under cost-reimbursement type subcontracts shall not exceed the fee limitations in FAR 15.404-4(c)(4)(i).

(i) The Contractor shall give the Contracting Officer immediate written notice of any action or suit filed and prompt notice of any claim made against the Contractor by any subcontractor or vendor that, in the opinion of the Contractor, may result in litigation related in any way to this contract, with respect to which the Contractor may be entitled to reimbursement from the Government.

(j) The Government reserves the right to review the Contractor's purchasing system as set forth in FAR Subpart 44.3.

(k) Paragraphs (d) and (f) of this clause do not apply to the following subcontracts, which were evaluated during negotiations:

(End of clause)

80 52.245-1 PROPERTY RECORDS (APR 1984)

The Government shall maintain the Government's official property records in connection with Government property under this contract. The Government Property clause is hereby modified by deleting the requirement for the Contractor to maintain such records.

(End of clause)

(AV 7-104.24(g) 1967 AUG)

81 52.246-12 INSPECTION OF CONSTRUCTION (AUG 1996)

(a) Definition. "Work" includes, but is not limited to, materials, workmanship, and manufacture and fabrication of components.

(b) The Contractor shall maintain an adequate inspection system and perform such inspections as will ensure that the work performed under the contract conforms to contract requirements. The Contractor shall maintain complete inspection records and make them available to the Government. All work shall be conducted under the general direction of the Contracting

Officer and is subject to Government inspection and test at all places and at all reasonable times before acceptance to ensure strict compliance with the terms of the contract.

(c) Government inspections and tests are for the sole benefit of the Government and do not--

(1) Relieve the Contractor of responsibility for providing adequate quality control measures;

(2) Relieve the Contractor of responsibility for damage to or loss of the material before acceptance;

(3) Constitute or imply acceptance; or

(4) Affect the continuing rights of the Government after acceptance of the completed work under paragraph (i) below.

(d) The presence or absence of a Government inspector does not relieve the Contractor from any contract requirement, nor is the inspector authorized to change any term or condition of the specification without the Contracting Officer's written authorization.

(e) The Contractor shall promptly furnish, at no increase in contract price, all facilities, labor, and material reasonably needed for performing such safe and convenient inspections and tests as may be required by the Contracting Officer. The Government may charge to the Contractor any additional cost of inspection or test when work is not ready at the time specified by the Contractor for inspection or test, or when prior rejection makes reinspection or retest necessary. The Government shall perform all inspections and tests in a manner that will not unnecessarily delay the work. Special, full size, and performance tests shall be performed as described in the contract.

(f) The Contractor shall, without charge, replace or correct work found by the Government not to conform to contract requirements, unless in the public interest the Government consents to accept the work with an appropriate adjustment in contract price. The Contractor shall promptly segregate and remove rejected material from the premises.

(g) If the Contractor does not promptly replace or correct rejected work, the Government may (1) by contract or otherwise, replace or correct the work and charge the cost to the Contractor or (2) terminate for default the Contractor's right to proceed.

(h) If, before acceptance of the entire work, the Government decides to examine already completed work by removing it or tearing it out, the Contractor, on request, shall promptly furnish all necessary facilities, labor, and material. If the work is found to be defective or nonconforming in any material respect due to the fault of the Contractor or its subcontractors, the Contractor shall defray the expenses of the examination and of satisfactory reconstruction. However, if the work is found to meet contract requirements, the Contracting Officer shall make an equitable adjustment for the additional services involved in the examination and reconstruction, including, if completion of the work was thereby delayed, an extension of time.

(i) Unless otherwise specified in the contract, the Government shall accept, as promptly as practicable after completion and inspection, all work required by the contract or that portion of the work the Contracting



Officer determines can be accepted separately. Acceptance shall be final and conclusive except for latent defects, fraud, gross mistakes amounting to fraud, or the Government's rights under any warranty or guarantee.  
(End of clause)

82 52.248-3 I VALUE ENGINEERING--CONSTRUCTION (MAR 1989)--ALTERNATE I  
(APR 1984)

(a) General. The Contractor is encouraged to develop, prepare, and submit value engineering change proposals (VECP's) voluntarily. The Contractor shall share in any instant contract savings realized from accepted VECP's, in accordance with paragraph (f) below.

(b) Definitions. "Collateral costs," as used in this clause, means agency costs of operation, maintenance, logistic support, or Government-furnished property.

"Collateral savings," as used in this clause, means those measurable net reductions resulting from a VECP in the agency's overall projected collateral costs, exclusive of acquisition savings, whether or not the acquisition cost changes.

"Contractor's development and implementation costs," as used in this clause, means those costs the Contractor incurs on a VECP specifically in developing, testing, preparing, and submitting the VECP, as well as those costs the Contractor incurs to make the contractual changes required by Government acceptance of a VECP.

"Government costs," as used in this clause, means those agency costs that result directly from developing and implementing the VECP, such as any net increases in the cost of testing, operations, maintenance, and logistic support. The term does not include the normal administrative costs of processing the VECP.

"Instant contract savings," as used in this clause, means the estimated reduction in Contractor cost of performance resulting from acceptance of the VECP, minus allowable Contractor's development and implementation costs, including subcontractors' development and implementation costs (see paragraph (h) below).

"Value engineering change proposal (VECP)" means a proposal that--

- (1) Requires a change to this, the instant contract, to implement; and
- (2) Results in reducing the contract price or estimated cost without impairing essential functions or characteristics; provided, that it does not involve a change--

- (i) In deliverable end item quantities only; or
- (ii) To the contract type only.

(c) VECP preparation. As a minimum, the Contractor shall include in each VECP the information described in subparagraphs (1) through (7) below. If the proposed change is affected by contractually required configuration management or similar procedures, the instructions in those procedures relating to format, identification, and priority assignment shall govern VECP preparation. The VECP shall include the following:

- (1) A description of the difference between the existing contract requirement and that proposed, the comparative advantages and disadvantages of each, a justification when an item's function or characteristics are being altered, and the effect of the change on the

end item's performance.

(2) A list and analysis of the contract requirements that must be changed if the VECP is accepted, including any suggested specification revisions.

(3) A separate, detailed cost estimate for (i) the affected portions of the existing contract requirement and (ii) the VECP. The cost reduction associated with the VECP shall take into account the Contractor's allowable development and implementation costs, including any amount attributable to subcontracts under paragraph (h) below.

(4) A description and estimate of costs the Government may incur in implementing the VECP, such as test and evaluation and operating and support costs.

(5) A prediction of any effects the proposed change would have on collateral costs to the agency.

(6) A statement of the time by which a contract modification accepting the VECP must be issued in order to achieve the maximum cost reduction, noting any effect on the contract completion time or delivery schedule.

(7) Identification of any previous submissions of the VECP, including the dates submitted, the agencies and contract numbers involved, and previous Government actions, if known.

(d) Submission. The Contractor shall submit VECP's to the Resident Engineer at the worksite, with a copy to the Contracting Officer.

(e) Government action. (1) The Contracting Officer shall notify the Contractor of the status of the VECP within 45 calendar days after the contracting office receives it. If additional time is required, the Contracting Officer shall notify the Contractor within the 45-day period and provide the reason for the delay and the expected date of the decision. The Government will process VECP's expeditiously; however, it shall not be liable for any delay in acting upon a VECP.

(2) If the VECP is not accepted, the Contracting Officer shall notify the Contractor in writing, explaining the reasons for rejection. The Contractor may withdraw any VECP, in whole or in part, at any time before it is accepted by the Government. The Contracting Officer may require that the Contractor provide written notification before undertaking significant expenditures for VECP effort.

(3) Any VECP may be accepted, in whole or in part, by the Contracting Officer's award of a modification to this contract citing this clause. The Contracting Officer may accept the VECP, even though an agreement on price reduction has not been reached, by issuing the Contractor a notice to proceed with the change. Until a notice to proceed is issued or a contract modification applies a VECP to this contract, the Contractor shall perform in accordance with the existing contract. The Contracting Officer's decision to accept or reject all or part of any VECP shall be final and not subject to the Disputes clause or otherwise subject to litigation under the Contract Disputes Act of 1978 (41 U.S.C. 601-613).

(f) Sharing. (1) Rates. The Government's share of savings is determined by subtracting Government costs from instant contract savings and multiplying the result by (i) 45 percent for fixed-price contracts or (ii) 75 percent for cost-reimbursement contracts.

(2) Payment. Payment of any share due the Contractor for use of a VECP on this contract shall be authorized by a modification to this contract to--

- (i) Accept the VECP;
- (ii) Reduce the contract price or estimated cost by the amount of instant contract savings; and
- (iii) Provide the Contractor's share of savings by adding the amount calculated to the contract price or fee.

(g) Subcontracts. The Contractor shall include an appropriate value engineering clause in any subcontract of \$50,000 or more and may include one in subcontracts of lesser value. In computing any adjustment in this contract's price under paragraph (f) above, the Contractor's allowable development and implementation costs shall include any subcontractor's allowable development and implementation costs clearly resulting from a VECP accepted by the Government under this contract, but shall exclude any value engineering incentive payments to a subcontractor. The Contractor may choose any arrangement for subcontractor value engineering incentive payments; provided, that these payments shall not reduce the Government's share of the savings resulting from the VECP.

(h) Data. The Contractor may restrict the Government's right to use any part of a VECP or the supporting data by marking the following legend on the affected parts:

"These data, furnished under the Value Engineering--Construction clause of contract \_\_\_\_\_, shall not be disclosed outside the Government or duplicated, used, or disclosed, in whole or in part, for any purpose other than to evaluate a value engineering change proposal submitted under the clause. This restriction does not limit the Government's right to use information contained in these data if it has been obtained or is otherwise available from the Contractor or from another source without limitations."

If a VECP is accepted, the Contractor hereby grants the Government unlimited rights in the VECP and supporting data, except that, with respect to data qualifying and submitted as limited rights technical data, the Government shall have the rights specified in the contract modification implementing the VECP and shall appropriately mark the data. (The terms "unlimited rights" and "limited rights" are defined in Part 27 of the Federal Acquisition Regulation.)

(End of clause)

83    52.249-2 I    TERMINATION FOR CONVENIENCE OF THE GOVERNMENT (FIXED-PRICE)  
(SEP 1996)--ALTERNATE I (SEP 1996)

(a) The Government may terminate performance of work under this contract in whole or, from time to time, in part if the Contracting Officer determines that a termination is in the Government's interest. The Contracting Officer shall terminate by delivering to the Contractor a Notice of Termination specifying the extent of termination and the effective date.

(b) After receipt of a Notice of Termination, and except as directed by the Contracting Officer, the Contractor shall immediately proceed with the following obligations, regardless of any delay in determining or adjusting any amounts due under this clause:

- (1) Stop work as specified in the notice.
- (2) Place no further subcontracts or orders (referred to as

subcontracts in this clause) for materials, services, or facilities, except as necessary to complete the continued portion of the contract.

(3) Terminate all subcontracts to the extent they relate to the work terminated.

(4) Assign to the Government, as directed by the Contracting Officer, all right, title, and interest of the Contractor under the subcontracts terminated, in which case the Government shall have the right to settle or to pay any termination settlement proposal arising out of those terminations.

(5) With approval or ratification to the extent required by the Contracting Officer, settle all outstanding liabilities and termination settlement proposals arising from the termination of subcontracts; the approval or ratification will be final for purposes of this clause.

(6) As directed by the Contracting Officer, transfer title and deliver to the Government (i) the fabricated or unfabricated parts, work in process, completed work, supplies, and other material produced or acquired for the work terminated, and (ii) the completed or partially completed plans, drawings, information, and other property that, if the contract had been completed, would be required to be furnished to the Government.

(7) Complete performance of the work not terminated.

(8) Take any action that may be necessary, or that the Contracting Officer may direct, for the protection and preservation of the property related to this contract that is in the possession of the Contractor and in which the Government has or may acquire an interest.

(9) Use its best efforts to sell, as directed or authorized by the Contracting Officer, any property of the types referred to in subparagraph (b)(6) of this clause; provided, however, that the Contractor (i) is not required to extend credit to any purchaser and (ii) may acquire the property under the conditions prescribed by, and at prices approved by, the Contracting Officer. The proceeds of any transfer or disposition will be applied to reduce any payments to be made by the Government under this contract, credited to the price or cost of the work, or paid in any other manner directed by the Contracting Officer.

(c) The Contractor shall submit complete termination inventory schedules no later than 120 days from the effective date of termination, unless extended in writing by the Contracting Officer upon written request of the Contractor within this 120-day period.

(d) After expiration of the plant clearance period as defined in Subpart 45.6 of the Federal Acquisition Regulation, the Contractor may submit to the Contracting Officer a list, certified as to quantity and quality, of termination inventory not previously disposed of, excluding items authorized for disposition by the Contracting Officer. The Contractor may request the Government to remove those items or enter into an agreement for their storage. Within 15 days, the Government will accept title to those items and remove them or enter into a storage agreement. The Contracting Officer may verify the list upon removal of the items, or if stored, within 45 days from submission of the list, and shall correct the list, as necessary, before final settlement.

(e) After termination, the Contractor shall submit a final termination settlement proposal to the Contracting Officer in the form and with the

certification prescribed by the Contracting Officer. The Contractor shall submit the proposal promptly, but no later than 1 year from the effective date of termination, unless extended in writing by the Contracting Officer upon written request of the Contractor within this 1 year period. However, if the Contracting Officer determines that the facts justify it, a termination settlement proposal may be received and acted on after 1 year or any extension. If the Contractor fails to submit the proposal within the time allowed, the Contracting Officer may determine, on the basis of information available, the amount, if any, due the Contractor because of the termination and shall pay the amount determined.

(f) Subject to paragraph (e) of this clause, the Contractor and the Contracting Officer may agree upon the whole or any part of the amount to be paid or remaining to be paid because of the termination. The amount may include a reasonable allowance for profit on work done. However, the agreed amount, whether under this paragraph (f) or paragraph (g) of this clause, exclusive of costs shown in subparagraph (g)(3) of this clause, may not exceed the total contract price as reduced by (1) the amount of payments previously made and (2) the contract price of work not terminated. The contract shall be modified, and the Contractor paid the agreed amount. Paragraph (g) of this clause shall not limit, restrict, or affect the amount that may be agreed upon to be paid under this paragraph.

(g) If the Contractor and Contracting Officer fail to agree on the whole amount to be paid the Contractor because of the termination of work, the Contracting Officer shall pay the Contractor the amounts determined as follows, but without duplication of any amounts agreed upon under paragraph (f) of this clause:

(1) For contract work performed before the effective date of termination, the total (without duplication of any items) of--

(i) The cost of this work;

(ii) The cost of settling and paying termination settlement proposals under terminated subcontracts that are properly chargeable to the terminated portion of the contract if not included in subdivision (g)(1)(i) of this clause; and

(iii) A sum, as profit on subdivision (g)(1)(i) of this clause, determined by the Contracting Officer under 49.202 of the Federal Acquisition Regulation, in effect on the date of this contract, to be fair and reasonable; however, if it appears that the Contractor would have sustained a loss on the entire contract had it been completed, the Contracting Officer shall allow no profit under this subdivision (iii) and shall reduce the settlement to reflect the indicated rate of loss.

(2) The reasonable costs of settlement of the work terminated, including--

(i) Accounting, legal, clerical, and other expenses reasonably necessary for the preparation of termination settlement proposals and supporting data;

(ii) The termination and settlement of subcontracts (excluding the amounts of such settlements); and

(iii) Storage, transportation, and other costs incurred, reasonably necessary for the preservation, protection, or disposition of the termination inventory.

(h) Except for normal spoilage, and except to the extent that the Government expressly assumed the risk of loss, the Contracting Officer

shall exclude from the amounts payable to the Contractor under paragraph (g) of this clause, the fair value, as determined by the Contracting Officer, of property that is destroyed, lost, stolen, or damaged so as to become undeliverable to the Government or to a buyer.

(i) The cost principles and procedures of Part 31 of the Federal Acquisition Regulation, in effect on the date of this contract, shall govern all costs claimed, agreed to, or determined under this clause.

(j) The Contractor shall have the right of appeal, under the Disputes clause, from any determination made by the Contracting Officer under paragraph (e), (g), or (l) of this clause, except that if the Contractor failed to submit the termination settlement proposal or request for equitable adjustment within the time provided in paragraph (e) or (l), respectively, and failed to request a time extension, there is no right of appeal.

(k) In arriving at the amount due the Contractor under this clause, there shall be deducted--

(1) All unliquidated advance or other payments to the Contractor under the terminated portion of this contract;

(2) Any claim which the Government has against the Contractor under this contract; and

(3) The agreed price for, or the proceeds of sale of, materials, supplies, or other things acquired by the Contractor or sold under the provisions of this clause and not recovered by or credited to the Government.

(l) If the termination is partial, the Contractor may file a proposal with the Contracting Officer for an equitable adjustment of the price(s) of the continued portion of the contract. The Contracting Officer shall make any equitable adjustment agreed upon. Any proposal by the Contractor for an equitable adjustment under this clause shall be requested within 90 days from the effective date of termination unless extended in writing by the Contracting Officer.

(m)(1) The Government may, under the terms and conditions it prescribes, make partial payments and payments against costs incurred by the Contractor for the terminated portion of the contract, if the Contracting Officer believes the total of these payments will not exceed the amount to which the Contractor will be entitled.

(2) If the total payments exceed the amount finally determined to be due, the Contractor shall repay the excess to the Government upon demand, together with interest computed at the rate established by the Secretary of the Treasury under 50 U.S.C. App. 1215(b)(2). Interest shall be computed for the period from the date the excess payment is received by the Contractor to the date the excess is repaid. Interest shall not be charged on any excess payment due to a reduction in the Contractor's termination settlement proposal because of retention or other disposition of termination inventory until 10 days after the date of the retention or disposition, or a later date determined by the Contracting Officer because of the circumstances.

(n) Unless otherwise provided in this contract or by statute, the Contractor shall maintain all records and documents relating to the terminated portion of this contract for 3 years after final settlement. This includes all books and other evidence bearing on the Contractor's costs and expenses under this contract. The Contractor shall make these

records and documents available to the Government, at the Contractor's office, at all reasonable times, without any direct charge. If approved by the Contracting Officer, photographs, microphotographs, or other authentic reproductions may be maintained instead of original records and documents.

(End of clause)

84 52.249-10 DEFAULT (FIXED-PRICE CONSTRUCTION) (APR 1984)

(a) If the Contractor refuses or fails to prosecute the work or any separable part, with the diligence that will insure its completion within the time specified in this contract including any extension, or fails to complete the work within this time, the Government may, by written notice to the Contractor, terminate the right to proceed with the work (or the separable part of the work) that has been delayed. In this event, the Government may take over the work and complete it by contract or otherwise, and may take possession of and use any materials, appliances, and plant on the work site necessary for completing the work. The Contractor and its sureties shall be liable for any damage to the Government resulting from the Contractor's refusal or failure to complete the work within the specified time, whether or not the Contractor's right to proceed with the work is terminated. This liability includes any increased costs incurred by the Government in completing the work.

(b) The Contractor's right to proceed shall not be terminated nor the Contractor charged with damages under this clause, if-

(1) The delay in completing the work arises from unforeseeable causes beyond the control and without the fault or negligence of the Contractor. Examples of such causes include (i) acts of God or of the public enemy, (ii) acts of the Government in either its sovereign or contractual capacity, (iii) acts of another Contractor in the performance of a contract with the Government, (iv) fires, (v) floods, (vi) epidemics, (vii) quarantine restrictions, (viii) strikes, (ix) freight embargoes, (x) unusually severe weather, or (xi) delays of subcontractors or suppliers at any tier arising from unforeseeable causes beyond the control and without the fault or negligence of both the Contractor and the subcontractors or suppliers; and

(2) The Contractor, within 10 days from the beginning of any delay (unless extended by the Contracting Officer), notifies the Contracting Officer in writing of the causes of delay. The Contracting Officer shall ascertain the facts and the extent of delay. If, in the judgment of the Contracting Officer, the findings of fact warrant such action, the time for completing the work shall be extended. The findings of the Contracting Officer shall be final and conclusive on the parties, but subject to appeal under the Disputes clause.

(c) If, after termination of the Contractor's right to proceed, it is determined that the Contractor was not in default, or that the delay was excusable, the rights and obligations of the parties will be the same as if the termination had been issued for the convenience of the Government.

(d) The rights and remedies of the Government in this clause are in addition to any other rights and remedies provided by law or under this contract.

(End of clause)

85 52.201-7000 CONTRACTING OFFICER'S REPRESENTATIVE (DEC 1991)

(a) Definition. "Contracting officer's representative" means an individual designated in accordance with subsection 201.602-2 of the Defense Federal Acquisition Regulation Supplement and authorized in writing by the Contracting Officer to perform specific technical or administrative functions.

(b) If the Contracting Officer designates a contracting officer's representative (COR), the Contractor will receive a copy of the written designation. It will specify the extent of the COR's authority to act on behalf of the Contracting Officer. The COR is not authorized to make any commitments or changes that will affect price, quality, quantity, delivery, or any other term or condition of the contract.

(End of clause)

86 52.203-7001 SPECIAL PROHIBITION ON EMPLOYMENT (JUN 1997)

(a) Definitions.

As used in this clause--

(1) "Arising out of a contract with the DoD" means any act in connection with--

(i) Attempting to obtain,

(ii) Obtaining, or

(iii) Performing a contract or first-tier subcontract of any agency, department, or component of the Department of Defense (DoD).

(2) "Conviction of fraud or any other felony" means any conviction for fraud or a felony in violation of state or Federal criminal statutes, whether entered on a verdict or plea, including a plea of nolo contendere, for which sentence has been imposed.

(3) "Date of conviction" means the date judgment was entered against the individual.

(b) 10 U.S.C. 2408 provides that any individual who is convicted after September 29, 1988, of fraud or any other felony arising out of a contract with the DoD is prohibited from:

(1) Working in a management or supervisory capacity on any DoD contract or first-tier subcontract;

(2) Serving on the board of directors of any DoD Contractor or first-tier subcontractor; or

(3) Serving as a consultant to any DoD Contractor or first-tier subcontractor.

(c) Unless waived, the prohibition in paragraph (b) applies for five years from the date of conviction.

(d) 10 U.S.C. 2408 further provides that a defense Contractor or first-tier subcontractor shall be subject to a criminal penalty of not more than



\$500,000 if convicted of knowingly--

(1) Employing a person under a prohibition specified in paragraph (b) of this clause; or

(2) Allowing such a person to serve on the board of directors of the Contractor or first-tier subcontractor.

(e) In addition to the criminal penalties contained in 10 U.S.C. 2408, the Government may consider other available remedies, such as--

(1) Suspension or debarment;

(2) Cancellation of the contract at no cost to the Government; or

(3) Termination of the contract for default.

(f) The Contractor may submit written requests for waiver of the prohibitions in paragraph (b) of this clause to the Contracting Officer. Requests shall clearly identify--

(1) The person involved;

(2) The nature of the conviction and resultant sentence or punishment imposed;

(3) The reasons for the requested waiver; and,

(4) An explanation of why a waiver is in the interest of national security.

(g) The Contractor agrees to include the substance of this clause, appropriately modified to reflect the identity and relationship of the parties, in all first-tier subcontracts exceeding the simplified acquisition threshold in Part 2 of the Federal Acquisition Regulation, except those for commercial items or components.

(h) Pursuant to 10 U.S.C. 2408(c), defense contractors and subcontractors may obtain information as to whether a particular person has been convicted of fraud or any other felony arising out of a contract with the DoD by contacting The Office of Justice Programs, The Denial of Benefits Office, U.S. Department of Justice, telephone (202) 616-3507.

(End of clause)

87 52.203-7002 DISPLAY OF DOD HOTLINE POSTER (DEC 1991)

(a) The Contractor shall display prominently in common work areas within business segments performing work under Department of Defense (DoD) contracts, DoD Hotline Posters prepared by the DoD Office of the Inspector General.

(b) DoD Hotline Posters may be obtained from the DoD Inspector General, ATTN: Defense Hotline, 400 Army Navy Drive, Washington, DC 22202-2884.

(c) The Contractor need not comply with paragraph (a) of this clause if it has established a mechanism, such as a hotline, by which employees may report suspected instances of improper conduct, and instructions that encourage employees to make such reports.

(End of clause)

88 52.204-7003 CONTROL OF GOVERNMENT PERSONNEL WORK PRODUCT (APR 1992)

The Contractor's procedures for protecting against unauthorized disclosure of information shall not require Department of Defense employees

or members of the Armed Forces to relinquish control of their work products, whether classified or not, to the Contractor.  
(End of clause)

89 52.219-7003 SMALL, SMALL DISADVANTAGED AND WOMEN-OWNED SMALL BUSINESS  
SUBCONTRACTING PLAN (DoD CONTRACTS) (APR 1996)

This clause supplements the Federal Acquisition Regulation 52.219-9, Small, Small Disadvantaged and Women-Owned Small Business Subcontracting Plan, clause of this contract.

(a) Definitions.

"Historically black colleges and universities," as used in this clause, means institutions determined by the Secretary of Education to meet the requirements of 34 CFR 608.2. The term also means any nonprofit research institution that was an integral part of such a college or university before November 14, 1986.

"Minority institutions," as used in this clause, means institutions meeting the requirements of section 1046(3) of the Higher Education Act of 1965 (20 U.S.C. 1135d-5(3)). The term also includes Hispanic-serving institutions as defined in section 316(b)(1) of such Act (20 U.S.C. 1059c(b)(1)).

(b) Except for company or division-wide commercial items subcontracting plans, the term "small disadvantaged business," when used in the FAR 52.219-9 clause, includes historically black colleges and universities and minority institutions, in addition to small disadvantaged business concerns.

(c) Work under the contract or its subcontracts shall be credited toward meeting the small disadvantaged business concern goal required by paragraph (d) of the FAR 52.219-9 clause when:

(1) It is performed on Indian lands or in joint venture with an Indian tribe or a tribally-owned corporation, and

(2) It meets the requirements of 10 U.S.C. 2323a.

(d) Subcontracts awarded to workshops approved by the Committee for Purchase from People Who are Blind or Severely Disabled (41 U.S.C. 46-48), may be counted toward the Contractor's small business subcontracting goal.

(e) A mentor firm, under the Pilot Mentor-Protege Program established under Section 831 of Pub. L. 101-510, as amended, may count toward its small disadvantaged business goal, subcontracts awarded--

(1) Protege firms which are qualified organizations employing the severely handicapped; and

(2) Former protege firms that meet the criteria in Section 831(g)(4) of Pub. L. 101-510.

(f) The master plan approval referred to in paragraph (f) of the FAR 52.219-9 clause is approval by the Contractor's cognizant contract administration activity.

(g) In those subcontracting plans which specifically identify small, small disadvantaged, and women-owned small businesses, the Contractor shall notify the Administrative Contracting Officer of any substitutions of firms that are not small, small disadvantaged, or women-owned small businesses for the firms listed in the subcontracting plan. Notifications shall be in

writing and shall occur within a reasonable period of time after award of the subcontract. Contractor-specified formats shall be acceptable.  
(End of clause)

90 52. 223- 7004 DRUG-FREE WORK FORCE (SEP 1988)

(a) Definitions.

(1) "Employee in a sensitive position," as used in this clause, means an employee who has been granted access to classified information; or employees in other positions that the Contractor determines involve national security, health or safety, or functions other than the foregoing requiring a high degree of trust and confidence.

(2) "Illegal drugs," as used in this clause, means controlled substances included in Schedules I and II, as defined by section 802(6) of Title 21 of the United States Code, the possession of which is unlawful under Chapter 13 of that Title. The term "illegal drugs" does not mean the use of a controlled substance pursuant to a valid prescription or other uses authorized by law.

(b) The Contractor agrees to institute and maintain a program for achieving the objective of a drug-free work force. While this clause defines criteria for such a program, contractors are encouraged to implement alternative approaches comparable to the criteria in paragraph (c) that are designed to achieve the objectives of this clause.

(c) Contractor programs shall include the following, or appropriate alternatives:

(1) Employee assistance programs emphasizing high level direction, education, counseling, rehabilitation, and coordination with available community resources;

(2) Supervisory training to assist in identifying and addressing illegal drug use by Contractor employees;

(3) Provision for self-referrals as well as supervisory referrals to treatment with maximum respect for individual confidentiality consistent with safety and security issues;

(4) Provision for identifying illegal drug users, including testing on a controlled and carefully monitored basis. Employee drug testing programs shall be established taking account of the following:

(i) The Contractor shall establish a program that provides for testing for the use of illegal drugs by employees in sensitive positions. The extent of and criteria for such testing shall be determined by the Contractor based on considerations that include the nature of the work being performed under the contract, the employee's duties, the efficient use of Contractor resources, and the risks to health, safety, or national security that could result from the failure of an employee adequately to discharge his or her position.

(ii) In addition, the Contractor may establish a program for employee drug testing--

(A) When there is a reasonable suspicion that an employee uses illegal drugs; or

(B) When an employee has been involved in an accident or unsafe practice;

(C) As part of or as a follow-up to counseling or rehabilitation

for illegal drug use;

(D) As part of a voluntary employee drug testing program

(iii) The Contractor may establish a program to test applicants for employment for illegal drug use.

(iv) For the purpose of administering this clause, testing for illegal drugs may be limited to those substances for which testing is prescribed by section 2.1 of Subpart B of the "Mandatory Guidelines for Federal Workplace Drug Testing Programs" (53 FR 11980 (April 11 1988)), issued by the Department of Health and Human Services.

(d) Contractors shall adopt appropriate personnel procedures to deal with employees who are found to be using drugs illegally. Contractors shall not allow any employee to remain on duty or perform in a sensitive position who is found to use illegal drugs until such time as the Contractor, in accordance with procedures established by the Contractor, determines that the employee may perform in such a position.

(e) The provisions of this clause pertaining to drug testing programs shall not apply to the extent they are inconsistent with state or local law, or with an existing collective bargaining agreement; provided that with respect to the latter, the Contractor agrees that those issues that are in conflict will be a subject of negotiation at the next collective bargaining session.

(End of clause)

91 52. 225- 7012 PREFERENCE FOR CERTAIN DOMESTIC COMMODITIES (SEP 1997)

(a) The Contractor agrees to deliver under this contract only such of the following articles that have been grown, reprocessed, reused, or produced in the United States, its possessions, or Puerto Rico--

- (1) Food;
- (2) Clothing;
- (3) Tents, tarpaulins, or covers;
- (4) Cotton and other natural fiber products;
- (5) Woven silk or woven silk blends;
- (6) Spun silk yarn for cartridge cloth;
- (7) Synthetic fabric, and coated synthetic fabric, including all textile fibers and yarns that are for use in such fabrics;
- (8) Canvas products;
- (9) Wool (whether in the form of fiber or yarn or contained in fabrics, materials, or manufactured articles); or
- (10) Any item of individual equipment (Federal Supply Class 8465) manufactured from or containing such fibers, yarns, fabrics, or materials.

(b) This clause does not apply--

- (1) To supplies listed in FAR 25.108(d)(1), or other supplies for which the Government has determined that a satisfactory quality and sufficient quantity cannot be acquired as and when needed at U.S. market prices;
- (2) To foods which have been manufactured or processed in the United States, its possessions, or Puerto Rico;
- (3) To chemical warfare protective clothing produced in the countries listed in subsection 225.872-1 of the Defense FAR Supplement; or
- (4) To purchase of fibers and yarns that are for use in synthetic

fabric or coated synthetic fabric (but not the purchase of the synthetic or coated synthetic fabric itself), if such fabric is to be used as a component of an end item that is not a textile product. Examples of textile products, made in whole or in part of fabric, include--

- (i) Draperies, floor coverings, furnishings, and bedding (Federal Supply Group 72, Household and Commercial Furnishings and Appliances);
  - (ii) Items made in whole or in part of fabric in Federal Supply Group 83, Textile/leather/furs/apparel/findings/tents/flags, or Federal Supply Group 84, Clothing, Individual Equipment and Insignia;
  - (iii) Upholstered seats (whether for household, office, or other use); and
  - (iv) Parachutes (Federal Supply Class 1670).
- (End of clause)

92    52.225-7026    REPORTING OF CONTRACT PERFORMANCE OUTSIDE THE UNITED STATES  
(MAR 1998)

(a) Reporting criteria.

Reporting under this clause is required for--

(1) Offers exceeding \$10 million, if the Offeror is aware at the time the offer is submitted that it or its first-tier subcontractor intends to perform any part of the contract that exceeds \$500,000 outside the United States and Canada, if that part could be performed inside the United States or Canada;

(2) Contracts exceeding \$10 million, when any part that exceeds \$500,000 could be performed inside the United States or Canada, but will be performed outside the United States and Canada. If the information was submitted with the offer, it need not be resubmitted unless it changes; and

(3) Contracts exceeding \$500,000, when any part that exceeds the simplified acquisition threshold in Part 2 of the Federal Acquisition Regulation will be performed outside the United States, unless a foreign place of performance is--

- (i) The principal place of performance; and
- (ii) Indicated by the Offeror's entry in the Place of Performance provision of the solicitation.

(b) Submission of reports.

(1) The Offeror shall submit reports required by paragraph (a)(1) of this clause with its offer.

(2) The Contractor shall submit reports required by paragraph (a)(2) of this clause to the Contracting Officer as soon as the information is known, with a copy to the addressee in paragraph (b)(3) of this clause. With respect to performance by a first-tier subcontractor, this information shall be reported, to the maximum extent practicable, at least 30 days before award of the subcontract.

(3) The Contractor shall submit reports required by paragraph (a)(3) of this clause within 10 days of the end of each Government quarter to--

Deputy Director of Defense Procurement (Foreign Contracting)  
OUSD(A&T)DP(FC)  
Washington, DC 20301-3060

(4) The Offeror/Contractor shall submit reports on DD Form 2139, Report of Contract Performance Outside the United States. Computer-generated reports are acceptable, provided the report contains all information required by DD Form 2139. Copies of DD Form 2139 may be obtained from the Contracting Officer.

(c) Flowdown requirements. (1) The Contractor shall include a clause substantially the same as this one in all first-tier subcontracts exceeding \$500,000, except subcontracts for commercial items, construction, ores, natural gases, utilities, petroleum products and crudes, timber (logs), or subsistence.

(2) The Contractor shall provide the prime contract number to subcontractors for reporting purposes.

(d) Information required.

Information to be reported on the part of this contract performed outside the United States (or outside the United States and Canada for reports required by paragraphs (a)(1) and (a)(2) of this clause) includes that for--

(1) Subcontracts;

(2) Purchases; and

(3) Intracompany transfers when transfers originate in a foreign location.

(End of clause)

93 52.227-7033 RIGHTS IN SHOP DRAWINGS (APR 1966)

(a) Shop drawings for construction means drawings, submitted to the Government by the Construction Contractor, subcontractor or any lower-tier subcontractor pursuant to a construction contract, showing in detail (i) the proposed fabrication and assembly of structural elements and (ii) the installation (i.e., form, fit, and attachment details) of materials or equipment. The Government may duplicate, use, and disclose in any manner and for any purpose shop drawings delivered under this contract.

(b) This clause, including this paragraph (b), shall be included in all subcontracts hereunder at any tier.

(End of clause)

94 52.231-7000 SUPPLEMENTAL COST PRINCIPLES (DEC 1991)

When the allowability of costs under this contract is determined in accordance with Part 31 of the Federal Acquisition Regulation (FAR), allowability shall also be determined in accordance with Part 231 of the Defense FAR Supplement, in effect on the date of this contract.

(End of clause)

95 52.236-7000 MODIFICATION PROPOSALS--PRICE BREAKDOWN (DEC 1991)

(a) The Contractor shall furnish a price breakdown, itemized as required and within the time specified by the Contracting Officer, with any proposal for a contract modification.

(b) The price breakdown--

(1) Must include sufficient detail to permit an analysis of profit, and of all costs for--

- (i) Material;
- (ii) Labor;
- (iii) Equipment;
- (iv) Subcontracts; and
- (v) Overhead; and

(2) Must cover all work involved in the modification, whether the work was deleted, added, or changed.

(c) The Contractor shall provide similar price breakdowns to support any amounts claimed for subcontracts.

(d) The Contractor's proposal shall include a justification for any time extension proposed.

(End of clause)

96 52.236-7008 CONTRACT PRICES--BIDDING SCHEDULES (DEC 1991)

(a) The Government's payment for the items listed in the Bidding Schedule shall constitute full compensation to the Contractor for--

(1) Furnishing all plant, labor, equipment, appliances, and materials; and

(2) Performing all operations required to complete the work in conformity with the drawings and specifications.

(b) The Contractor shall include in the prices for the items listed in the Bidding Schedule all costs for work in the specifications, whether or not specifically listed in the Bidding Schedule.

(End of provision)

97 52.242-7000 POSTAWARD CONFERENCE (DEC 1991)

The Contractor agrees to attend any postaward conference convened by the contracting activity or contract administration office in accordance with Federal Acquisition Regulation Subpart 42.5.

(End of clause)

98 52.243-7001 PRICING OF CONTRACT MODIFICATIONS (DEC 1991)

When costs are a factor in any price adjustment under this contract, the contract cost principles and procedures in FAR Part 31 and DFARS Part 231, in effect on the date of this contract, apply.

(End of clause)

99 52.247-7023 TRANSPORTATION OF SUPPLIES BY SEA (NOV 1995)

(a) Definitions. As used in this clause--

(1) "Components" means articles, materials, and supplies incorporated directly into end products at any level of manufacture, fabrication, or

assembly by the Contractor or any subcontractor.

(2) "Department of Defense (DoD)" means the Army, Navy, Air Force, Marine Corps, and defense agencies.

(3) "Foreign flag vessel" means any vessel that is not a U.S.-flag vessel.

(4) "Ocean transportation" means any transportation aboard a ship, vessel, boat, barge, or ferry through international waters.

(5) "Subcontractor" means a supplier, materialman, distributor, or vendor at any level below the prime contractor whose contractual obligation to perform results from, or is conditioned upon, award of the prime contract and who is performing any part of the work or other requirement of the prime contract. However, effective May 1, 1996, the term does not include a supplier, materialman, distributor, or vendor of commercial items or commercial components.

(6) "Supplies" means all property, except land and interests in land, that is clearly identifiable for eventual use by or owned by the DoD at the time of transportation by sea.

(i) An item is clearly identifiable for eventual use by the DoD if, for example, the contract documentation contains a reference to a DoD contract number or a military destination.

(ii) Supplies includes (but is not limited to) public works; buildings and facilities; ships; floating equipment and vessels of every character, type, and description, with parts, subassemblies, accessories, and equipment; machine tools; material; equipment; stores of all kinds; end items; construction materials; and components of the foregoing.

(7) "U.S.-flag vessel" means a vessel of the United States or belonging to the United States, including any vessel registered or having national status under the laws of the United States.

(b) The Contractor shall employ U.S.-flag vessels in the transportation by sea of any supplies to be furnished in the performance of this contract. The Contractor and its subcontractors may request that the Contracting Officer authorize shipment in foreign-flag vessels, or designate available U.S.-flag vessels, if the Contractor or a subcontractor believes that--

(1) U.S.-flag vessels are not available for timely shipment;

(2) The freight charges are inordinately excessive or unreasonable; or

(3) Freight charges are higher than charges to private persons for transportation of like goods.

(c) The Contractor must submit any request for use of other than U.S.-flag vessels in writing to the Contracting Officer at least 45 days prior to the sailing date necessary to meet its delivery schedules. The Contracting Officer will process requests submitted after such date(s) as expeditiously as possible, but the Contracting Officer's failure to grant approvals to meet the shipper's sailing date will not of itself constitute a compensable delay under this or any other clause of this contract.

Requests shall contain at a minimum--

(1) Type, weight, and cube of cargo;

(2) Required shipping date;

(3) Special handling and discharge requirements;

(4) Loading and discharge points;

(5) Name of shipper and consignee;

(6) Prime contract number; and



(7) A documented description of efforts made to secure U.S.-flag vessels, including points of contact (with names and telephone numbers) with at least two U.S.-flag carriers contacted. Copies of telephone notes, telegraphic and facsimile message or letters will be sufficient for this purpose.

(d) The Contractor shall, within 30 days after each shipment covered by this clause, provide the Contracting Officer and the Division of National Cargo, Office of Market Development, Maritime Administration, U.S. Department of Transportation, Washington, DC 20590, one copy of the rated on board vessel operating carrier's ocean bill of lading, which shall contain the following information--

- (1) Prime contract number;
- (2) Name of vessel;
- (3) Vessel flag of registry;
- (4) Date of loading;
- (5) Port of loading;
- (6) Port of final discharge;
- (7) Description of commodity;
- (8) Gross weight in pounds and cubic feet if available;
- (9) Total ocean freight in U.S. dollars; and
- (10) Name of the steamship company.

(e) The Contractor agrees to provide with its final invoice under this contract a representation that to the best of its knowledge and belief--

- (1) No ocean transportation was used in the performance of this contract;
- (2) Ocean transportation was used and only U.S.-flag vessels were used for all ocean shipments under the contract;
- (3) Ocean transportation was used, and the Contractor had the written consent of the Contracting Officer for all non-U.S.-flag ocean transportation; or
- (4) Ocean transportation was used and some or all of the shipments were made on non-U.S.-flag vessels without the written consent of the Contracting Officer. The Contractor shall describe these shipments in the following format:

	Item Description	Contract Line Items	Quantity
Total			

(f) If the final invoice does not include the required representation, the Government will reject and return it to the Contractor as an improper invoice for the purposes of the Prompt Payment clause of this contract. In the event there has been unauthorized use of non-U.S.-flag vessels in the performance of this contract, the Contracting Officer is entitled to equitably adjust the contract, based on the unauthorized use.

(g) The Contractor shall include this clause, including this paragraph (g) in all subcontracts under this contract, which exceed the simplified acquisition threshold in Part 13 of the Federal Acquisition Regulation.

(End of clause)

100 52.247-7024 NOTIFICATION OF TRANSPORTATION OF SUPPLIES BY SEA (NOV 1995)

(a) The Contractor has indicated by the response to the solicitation provision, Representation of Extent of Transportation by Sea, that it did

not anticipate transporting by sea any supplies. If, however, after the award of this contract, the Contractor learns that supplies, as defined in the Transportation of Supplies by Sea clause of this contract, will be transported by sea, the Contractor--

(1) Shall notify the Contracting Officer of that fact; and

(2) Hereby agrees to comply with all the terms and conditions of the Transportation of Supplies by Sea clause of this contract.

(b) The Contractor shall include this clause, including this paragraph (b), revised as necessary to reflect the relationship of the contracting parties, in all subcontracts hereunder, except (effective May 1, 1996) subcontracts for the acquisition of commercial items or components.

(End of clause)

101 52.0-4513            EQUIPMENT OWNERSHIP AND OPERATING EXPENSE SCHEDULE (EFARS  
52.231-5000) (MAR 1995)

(a) This clause does not apply to terminations. See 52.249-5000, Basis for Settlement of Proposals, and FAR Part 49.

(b) Allowable cost for construction and marine plant and equipment in sound workable condition owned or controlled and furnished by a Contractor or subcontractor at any tier shall be based on actual cost data for each piece of equipment or groups of similar serial and series for which the Government can determine both ownership and operating costs from the Contractor's accounting records. When both ownership and operating costs cannot be determined for any piece of equipment or groups of similar serial or series equipment from the Contractor's accounting records, costs for that equipment shall be based upon the applicable provisions for the applicable provisions of EP 1110-1-8, "Construction Equipment Ownership and Operating Expense Schedule." Region VI. Working conditions shall be considered to be average for determining equipment rates using the schedule unless specified otherwise by the Contracting Officer. For equipment not included in the schedule, rates for comparable pieces of equipment may be used or a rate may be developed using the formula provided in the schedule. For forward pricing, the Schedule in effect at the time of negotiations shall apply. For retroactive pricing, the Schedule in effect at the time the work was performed shall apply.

(c) Equipment rental costs are allowable, subject to the provision of FAR 31.105(d)(ii) and FAR 31.205-36. Rates for equipment rented from an organization under common control, lease-purchase arrangements, and sale-leaseback arrangements will be determined using the schedule except that actual rates will be used for equipment leased from an organization under common control that has an established practice of leasing the same or similar equipment to unaffiliated lessees.

(d) When actual equipment costs are proposed and the total amount of the pricing action exceeds the small purchase threshold, the contracting officer shall request the contractor to submit either certified cost or pricing data, or partial/limited data, as appropriate.

If the quantity of a unit-priced item in this contract is an estimated quantity and the actual quantity of the unit-priced item varies more than 15 percent above or below the estimated quantity, an equitable adjustment in the contract price shall be made upon demand of either party. The equitable adjustment shall be based upon any increase or decrease in costs due solely to the variation above 115 percent or below 85 percent of the estimated quantity. If the quantity variation is such as to cause an increase in the time necessary for completion, the Contractor may request, in writing, an extension of time, to be received by the Contracting Officer within 10 days from the beginning of the delay, or within such further period as may be granted by the Contracting Officer before the date of final settlement of the contract. Upon the receipt of a written request for an extension, the Contracting Officer shall ascertain the facts and make an adjustment for extending the completion date as, in the judgement of the Contracting Officer, is justified.

(End of clause)

END OF SECTION 00700

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## SECTION 00800

### SPECIAL CONTRACT REQUIREMENTS

#### 1 52.211-12 LIQUIDATED DAMAGES--CONSTRUCTION (APR 1984)

(a) If the Contractor fails to complete the work within the time specified in the contract, or any extension, the Contractor shall pay to the Government as liquidated damages, the sum of \$638.00 for each day of delay.

(b) If the Government terminates the Contractor's right to proceed, the resulting damage will consist of liquidated damages until such reasonable time as may be required for final completion of the work together with any increased costs occasioned the Government in completing the work.

(c) If the Government does not terminate the Contractor's right to proceed, the resulting damage will consist of liquidated damages until the work is completed or accepted.

(End of clause)

#### 2 52.211-13 TIME EXTENSIONS (APR 1984)

Notwithstanding any other provisions of this contract, it is mutually understood that the time extensions for changes in the work will depend upon the extent, if any, by which the changes cause delay in the completion of the various elements of construction. The change order granting the time extension may provide that the contract completion date will be extended only for those specific elements so delayed and that the remaining contract completion dates for all other portions of the work will not be altered and may further provide for an equitable readjustment of liquidated damages under the new completion schedule.

(End of clause)

#### 3 52.236-1 PERFORMANCE OF WORK BY THE CONTRACTOR (APR 1984)

The Contractor shall perform on the site, and with its own organization, work equivalent to at least twenty-five (25) percent of the total amount of work to be performed under the contract. This percentage may be reduced by a supplemental agreement to this contract if, during performing the work, the Contractor requests a reduction and the Contracting Officer determines that the reduction would be to the advantage of the Government.

(End of clause)

(R 7-603.15 1965 JAN)

(R 1-18.104)

#### 4 52.246-21 WARRANTY OF CONSTRUCTION (MAR 1994)

(a) In addition to any other warranties in this contract, the Contractor warrants, except as provided in paragraph (i) of this clause, that work

performed under this contract conforms to the contract requirements and is free of any defect in equipment, material, or design furnished, or workmanship performed by the Contractor or any subcontractor or supplier at any tier.

(b) This warranty shall continue for a period of 1 year from the date of final acceptance of the work. If the Government takes possession of any part of the work before final acceptance, this warranty shall continue for a period of 1 year from the date the Government takes possession.

(c) The Contractor shall remedy at the Contractor's expense any failure to conform, or any defect. In addition, the Contractor shall remedy at the Contractor's expense any damage to Government-owned or controlled real or personal property, when that damage is the result of--

(1) The Contractor's failure to conform to contract requirements; or

(2) Any defect of equipment, material, workmanship, or design furnished.

(d) The Contractor shall restore any work damaged in fulfilling the terms and conditions of this clause. The Contractor's warranty with respect to work repaired or replaced will run for 1 year from the date of repair or replacement.

(e) The Contracting Officer shall notify the Contractor, in writing, within a reasonable time after the discovery of any failure, defect, or damage.

(f) If the Contractor fails to remedy any failure, defect, or damage within a reasonable time after receipt of notice, the Government shall have the right to replace, repair, or otherwise remedy the failure, defect, or damage at the Contractor's expense.

(g) With respect to all warranties, express or implied, from subcontractors, manufacturers, or suppliers for work performed and materials furnished under this contract, the Contractor shall--

(1) Obtain all warranties that would be given in normal commercial practice;

(2) Require all warranties to be executed, in writing, for the benefit of the Government, if directed by the Contracting Officer; and

(3) Enforce all warranties for the benefit of the Government, if directed by the Contracting Officer.

(h) In the event the Contractor's warranty under paragraph (b) of this clause has expired, the Government may bring suit at its expense to enforce a subcontractor's, manufacturer's, or supplier's warranty.

(i) Unless a defect is caused by the negligence of the Contractor or subcontractor or supplier at any tier, the Contractor shall not be liable for the repair of any defects of material or design furnished by the Government nor for the repair of any damage that results from any defect in Government-furnished material or design.

(j) This warranty shall not limit the Government's rights under the Inspection and Acceptance clause of this contract with respect to latent defects, gross mistakes, or fraud.

(End of clause)

(R 7-604.4 1976 JUL)

5 52.236-7001 CONTRACT DRAWINGS, MAPS, AND SPECIFICATIONS (DEC 1991)

(a) The Government--

(1) Will provide the Contractor, without charge, 1 CD-ROM sets (five unless otherwise specified) of large-scale contract drawings and specifications except publications incorporated into the technical provisions by reference;

(2) Will furnish additional sets on request, for the cost of reproduction; and

(3) May, at its option, furnish the Contractor one set of reproducible, or half-size drawings, in lieu of the drawings in paragraph (a)(1) of this clause.

(b) The Contractor shall--

(1) Check all drawings furnished immediately upon receipt;

(2) Compare all drawings and verify the figures before laying out the work;

(3) Promptly notify the Contracting Officer of any discrepancies; and

(4) Be responsible for any errors which might have been avoided by complying with this paragraph (b).

(c) Large scale drawings shall, in general, govern small scale drawings. Figures marked on drawings shall, in general, be followed in preference to scale measurements.

(d) Omissions from the drawings or specifications or the misdescription of details of work which are manifestly necessary to carry out the intent of the drawings and specifications, or which are customarily performed, shall not relieve the Contractor from performing such omitted or misdescribed details of the work, but shall be performed as if fully and correctly set forth and described in the drawings and specifications.

(e) The work shall conform to the specifications and the contract drawings identified on the following index of drawings:

Title	File	and	Drawing No.
Whole Barracks Complex Renewal			
Fort Sill, Oklahoma			

(End of clause)

6 52.0-4001 CONTRACTING OFFICER

The Contracting Officer signing this contract is the primary Contracting Officer on this contract. However, any Contracting Officer assigned to the Tulsa District and acting within his authority may take formal action on this contract when a contract action needs to be taken and the primary Contracting Officer is away from the office.

7 52.0-4002 WAGE RATES

The following Wage Determination No. (s) are attached and made a part hereof: General Decision OK980014 with 5 Modifications dated 11/20/1998, and General Decision OK980001 with no Modifications dated 02/13/1998

8 52.0-4020 TIME EXTENSIONS FOR UNUSUALLY SEVERE WEATHER (OCT 89)  
(ER 415-1-15)

1. This provision specifies the procedure for determination of time extensions for unusually severe weather in accordance with the contract clause entitled "Default: (Fixed Price Construction)". In order for the Contracting Officer to award a time extension under this clause, the following conditions must be satisfied:

a. The weather experienced at the project site during the contract period must be found to be unusually severe, that is, more severe than the adverse weather anticipated for the project location during any given month.

b. The unusually severe weather must actually cause a delay to the completion of the project. The delay must be beyond the control and without the fault or negligence of the contractor.

2. The following schedule of monthly anticipated adverse weather delays is based on National Oceanic and Atmospheric Administration (NOAA) or similar data for the project location and will constitute the base line for monthly weather time evaluations. The contractor's progress schedule must reflect these anticipated adverse weather delays in all weather dependent activities.

MONTHLY ANTICIPATED ADVERSE WEATHER DELAY

WORK DAYS BASED ON (5) DAY WORK WEEK

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2	2	3	3	4	4	3	3	3	3	1	2

3. Upon acknowledgment of the Notice to Proceed (NTP) and continuing throughout the contract, the contractor will record on the daily CQC report, the occurrence of adverse weather and resultant impact to normally scheduled work. Actual adverse weather delay days must prevent work on critical activities for 50 percent or more of the contractor's scheduled work day. The number of actual adverse weather delay days shall include days impacted by actual adverse weather (even if adverse weather occurred in previous month), be calculated chronologically from the first to the last day of each month, and be recorded as full days. If the number of actual adverse weather delay days exceeds the number of days anticipated in paragraph 2, above, the contracting officer will convert any qualifying delays to calendar days, giving full consideration for equivalent fair weather work days, and issue a modification in accordance with the contract clause entitled "Default (Fixed Price Construction)".

(End of Clause)

9 52.0-4021 INCLUSION OF LABOR PROVISIONS IN SUBCONTRACTS (19 JUN 84)  
(DAEN-CCL LTR)

To show compliance with CONTRACT CLAUSE entitled "Subcontracts," The Contractor should, within 7 days after award of any subcontract either by himself or a subcontractor or any tier, deliver to the Contracting Officer a completed Standard Form 1413. Nothing contained in this clause



or any other provision of this contract shall create any contractual relation between any subcontractor and the Government.

(End of Clause)

10 52.0-4022 REQUIRED INSURANCE (APR 1984) (FAR 28.307-2)

Pursuant to the Contract Clause entitled "Insurance Work on a Government Installation", the Contractor shall procure and maintain during the entire period of his performance under this contract the following minimum insurance.

(a) Workmen's Compensation and Employers' Liability Insurance in compliance with applicable state statutes, with a minimum employers' liability coverage of \$100,000.

(b) Comprehensive General Liability Insurance for bodily injury in the minimum limits of \$500,000 per occurrence. No property damage liability insurance is required.

(c) Comprehensive Automobile Liability Insurance covering the operation of all automobiles used in connection with the performance of the contract in the minimum limits of \$200,000 per person and \$500,000 per occurrence for bodily injury and \$25,000 per occurrence for property damage.

The Contractor agrees to insert the substance of this clause, including this paragraph, in all subcontracts hereunder.

(End of Clause)

11 52.0-4030 BASIS FOR SETTLEMENT OF PROPOSALS (EFARS 52.249-5000) (MAR 1995)

"Actual costs will be used to determine equipment cost for a settlement proposal submitted on the total cost basis under FAR 49.206-2b. In evaluating a termination settlement proposal using the total cost basis, the following principles will be applied to determine allowable equipment costs:

(1) Actual costs for each piece of equipment, or groups of similar serial or series equipment, need not be available in the contractor's accounting records to determine total actual equipment costs.

(2) If equipment costs have been allocated to a contract using predetermined rates, those charges will be adjusted to actual costs.

(3) Recorded job costs adjusted for unallowable and unallocable expenses will be used to determine equipment operating expenses.

(4) Ownership costs (depreciation) will be determined using the contractor's depreciation schedule (subject to the provisions of FAR 31.205-11).

(5) License, taxes, storage and insurance costs are normally recovered as an indirect expense and unless the contractor charges these costs directly to contracts, they will be recovered through the indirect expense rate."

(End of Clause)

12 52.0-4050 TURFING WORK

(1) The Contractor shall complete turfing work within the time limits specified in Section: TURF with final completion not later than the first planting season following project completion stated in the clause entitled COMMENCEMENT, PROSECUTION, AND COMPLETION OF WORK.

(2) If the Contractor fails to complete the turfing work within the time specified, or any extension of time, the Contractor shall pay to the Government, as liquidated damages, the sum of \$100.00 for each day of delay in completing turfing.

(End of Clause)

13 52.0-4056 PARTNERING AGREEMENT

Tulsa District is an avid supporter and believer in the benefits of Partnering on our projects. Partnering is a necessary and valuable method of establishing mutual goals and working relationships among project participants, drawing on the strengths of each. As a result, the Contracting Officer or his/her representative will contact the contractor's management after contract award to discuss partnering for this project. Partnering opportunities will be explored and degree of partnering will be discussed. Hopefully, a partnering relationship will be implemented. The Partnering relationship will not be legally binding, but will represent a commitment to work together toward common goals.

The Contractor should not include any anticipated costs for partnering in the bid or proposal. The Partnering relationship will be bilateral and participation will be voluntary. The contractor is urged to consider Partnering as a means of promoting cooperation to the advantage of the contractor and the Government.

14 52.0-4071 COMMENCEMENT, PROSECUTION, AND COMPLETION OF WORK (APR 1984)  
FAR 52.0211-0010

The Contractor shall be required to (a) commence work under this contract within 10 calendar days after the date the Contractor receives the notice to proceed, (b) prosecute the work diligently, and (c) complete the entire work ready for use not later than

751 calendar days, with the exercise of either or both options increasing the duration an additional 80 calendar days. The time stated for completion shall include final cleanup of the premises.

15 52.0-4220 PAYMENT FOR MATERIALS DELIVERED OFF-SITE  
(EFARS 52.232-5000) (MAR 1995)

(a) Pursuant to FAR clause 52.232-5, Payments Under Fixed Priced Construction Contracts, materials delivered to the Contractor at locations other than the site of the work may be taken into consideration in making

payment if included in payment estimates and if all the conditions of the General Provisions are fulfilled. Payment for items delivered to locations other than the work site will be limited to: (1) materials required by the technical provisions; or (2) materials that have been fabricated to the point where they are identifiable to an item of work required under this contract.

(b) Such payment will be made only after receipt of paid or receipted invoices or invoices with canceled check showing title to the items in the prime contractor and including the value of material and labor incorporated into the item. In addition to petroleum products, payment for materials delivered off-site is limited to the following items: those items meeting the requirements of subparagraph (a) above.

16 52.0-4440 YEAR 2000 COMPLIANCE (CEPR-P memorandum dtd 1 Jul 98)

In accordance with FAR 39.106, the contractor shall ensure that, with respect to any design, construction, goods or services under this contract as well as any subsequent task/delivery orders issued under this contract (if applicable), all information technology contained therein shall be Year 2000 compliant. The contractor shall:

a) Perform, maintain, and provide an inventory of all major components to include structures, equipment, items, parts, and furnishings under this contract and each task/delivery order (if applicable) which may be affected by the Year 2000 compliant requirement.

b) Indicate whether each component is currently Year 2000 compliant or requires an upgrade for compliance prior to Government acceptance.

END OF SECTION 00800

GENERAL DECISION OK980001 02/13/98 OK1

Superseded General Decision No. OK970001

State: Oklahoma

Construction Type:

HIGHWAY

SEWER AND WATER LINE

County(ies):

COMANCHE

GARFIELD

SEQUOYAH

Construction, alteration, and/or repair of streets, highways, runways, erosion control structures, and water and sewer utilities, (but does not include building structures on highway rest areas).

Modification Number

0

Publication Date

02/13/1998

DACA56-99-B-0002, WHOLE BARRACKS RENEWAL COMPLEX, FORT SILL, COMANCHE COUNTY, OKLAHOMA

OK980001 - 1

02/13/1998

**00800- 8**

SUOK3002A 12/12/1991

	Rates	Fringes
AIR TOOL OPERATOR	\$6.50	
ASPHALT RAKER	6.75	
BLASTERS	8.75	
CARPENTER	8.50	
CONCRETE FINISHER PAVING	8.60	
CONCRETE FINISHER STRUCTURES	8.00	
CONCRETE RUBBER	6.50	
FORM BUILDER STRUCTURES	7.50	
FORM SETTER PAVING & CURB	7.50	
FORM SETTER STRUCTURES	7.50	
LABORER: COMMON	6.25	
MANHOLE INLET BUILDER	7.25	
MECHANIC	9.00	
PAINTER, STRUCTURES	7.00	
PILEDRIIVER	7.50	
PIPELAYER	7.50	
REINF. STEEL SETTER PAVING	7.50	
REINF. STEEL SETTER STRUCTURE	7.50	
SERVICER	7.75	
STEELWORKER STRUCTURAL	7.50	
FLAG PERSON	6.25	
SIGN ERECTOR	8.00	
SPREADER BOX PERSON	7.00	
TRAFFIC CONTROL DEVICE MONITOR	7.00	
TRAFFIC SIGNAL INSTALLER	11.50	
VIBRATOR PERSON (HAND TYPE)	6.25	
POWER EQUIPMENT OPERATORS:		
ASPHALT DISTRIBUTOR	7.55	
ASPHALT HOT MIX PLANT	8.50	
ASPHALT PAVING MACHINE	8.55	
ASPHALT PAVING MACHINE SCREED	8.55	
BACKHOE-LOADER	8.30	
BOX BLADE LOADER	7.55	
BROOM/SWEEPER	7.00	
BULLDOZER (150 H.P. & LESS)	8.40	
BULLDOZER (OVER 150 H.P.)	8.75	
CONCRETE MIXING PLANT	8.50	
CONCRETE PAVING CURING/TEXTURE/ FLOAT	8.50	
CONCRETE PAVING FORM GRADER	8.20	
CONCRETE PAVING GRINDER	7.60	
CONCRETE PAVING JOINT SEALER	7.75	
CONCRETE PAVING FINISHING MACHINE	8.55	
CONCRETE SAW OPERATOR	7.40	
CONCRETE SCREED MACHINE	7.75	
CONCRETE PAVING SPREADER	8.50	
 CURB MACHINE (SLIPFORM)	8.30	
REINFORCING STEEL MACHINE	7.40	

OK980001 - 2

02/13/1998

CRANE, CLAMSHELL, DERRICK, DRAGLINE, SHOVEL (1 1/2 C.Y. & LESS)	7.95
CRANE, CLAMSHELL, DERRICK, DRAGLINE, SHOVEL (OVER 1 1/2 C.Y.)	8.50
CRUSHER & SCREENING PLANT	8.25
FRONT END LOADER (2 1/2 C.Y. & LESS)	7.75
FRONT END LOADER (OVER 2 1/2 C.Y.)	8.45
HYDRAULIC EXCAVATOR	8.65
MOTOR GRADER (FINE GRADE)	9.05
MOTOR GRADER (ROUGH)	8.00
PAVEMENT MARKING MACHINE	8.00
PLANER, MILLING MACHINE	8.25
PUGMILL MIXING PLANT	7.15
PUMPCRETE	7.15
ROLLER STEEL WHEEL (PLANT-MIX)	7.85
ROLLER STEEL WHEEL (OTHER)	7.45
ROLLER PNEUMATIC (SELF- PROPELLED)	7.45
SCRAPER (17 C.Y. & LESS)	8.30
SCRAPER (OVER 17 C.Y.)	8.55
SELF-PROPELLED HAMMER	7.20
SIDE-BOOM	7.65
TRACTOR; CRAWLER (150 H.P. & LESS)	7.15
TRACTOR; CRAWLER (OVER 150 H.P.)	7.50
TRACTOR; PNEUMATIC (80 H.P. OR LESS)	7.45
TRACTOR; (OVER 80 H.P.)	7.65
TRAVELING MIXER	7.25
TRENCHING MACHINE	8.25
WAGON DRILL, BORING MACHINE OR POST HOLE	6.60
FOUNDATION DRILL, TRUCK MOUNTED	11.85
TRUCK DRIVERS:	
SINGLE AXLE, 2 TONS AND UNDER	6.85
SINGLE AXLE, OVER 2 TONS	7.05
TANDEM AXLE AND SEMI TRAILER	7.30
LOWBOY, FLOAT	8.60

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Welders - Receive rate prescribed for craft performing operation  
to which welding is incidental.

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Unlisted classifications needed for work not included within  
the scope of the classifications listed may be added after  
award only as provided in the labor standards contract clauses  
(29 CFR 5.5(a)(1)(v)).

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In the listing above, the "SU" designation means that rates  
listed under that identifier do not reflect collectively

bargained wage and fringe benefit rates. Other designations indicate unions whose rates have been determined to be prevailing.

#### WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

- \* an existing published wage determination
- \* a survey underlying a wage determination
- \* a Wage and Hour Division letter setting forth a position on a wage determination matter
- \* a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour Regional Office for the area in which the survey was conducted because those Regional Offices have responsibility for the Davis-Bacon survey program. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations  
Wage and Hour Division  
U. S. Department of Labor  
200 Constitution Avenue, N. W.  
Washington, D. C. 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator  
U.S. Department of Labor  
200 Constitution Avenue, N. W.  
Washington, D. C. 20210

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board  
U. S. Department of Labor  
200 Constitution Avenue, N. W.  
Washington, D. C. 20210

4.) All decisions by the Administrative Review Board are final.  
END OF GENERAL DECISION



GENERAL DECISION OK980014 10/30/98 OK14  
Superseded General Decision No. OK970014

State: Oklahoma

Construction Type:  
BUILDING

County(ies):

ALFALFA	GRADY	MAJOR
BECKHAM	GRANT	MARSHALL
BLAINE	GREER	MURRAY
CADDO	HARMON	NOBLE
CARTER	HARPER	PONTOTOC
COMANCHE	JACKSON	ROGER MILLS
COTTON	JEFFERSON	STEPHENS
CUSTER	JOHNSTON	TILLMAN
DEWEY	KAY	WASHITA
ELLIS	KINGFISHER	WOODS
GARFIELD	KIOWA	WOODWARD
GARVIN	LOVE	

BUILDING CONSTRUCTION PROJECTS (does not include residential construction consisting of single family homes and apartments up to and including 4 stories)

Modification Number	Publication Date
0	02/13/1998
1	03/13/1998
2	03/27/1998
3	08/28/1998
4	10/30/1998
5	11/20/1998

DACA56-99-B-0002, BARRACKS RENEWAL COMPLEX, FORT SILL, COMANCHE COUNTY, OK

OK980014 - 1

11/20/1998

Changed by Amendment 3

00800-13

ASBE0064C 07/16/1997		
	Rates	Fringes
KAY COUNTY		
ASBESTOS/INSULATOR WORKERS	15.00	4.64

SCOPE OF WORK:

Includes application of all insulating materials, protective coverings, coatings and finishings to all types of mechanical systems.

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ASBE0066C 07/01/1996		
	Rates	Fringes
BECKHAM, ELLIS, GREER, HARMON, HARPER AND ROGER MILLS COUNTIES		
ASBESTOS/INSULATOR WORKERS	15.13	4.24

Scope of Work:

Includes application of all insulation materials, protective coverings, coatings and finishings to all types of mechanical systems.

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ASBE0094C 07/16/1997		
	Rates	Fringes
REMAINING COUNTIES		
ASBESTOS/INSULATOR WORKERS	18.59	5.54

SCOPE OF WORK:

Includes application of all insulation materials, protective coverings and finishings to all types of mechanical systems.

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BOIL0592A 08/08/1996		
	Rates	Fringes
BOILERMAKER	18.48	5.54

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BROK0005Q 06/01/1995		
	Rates	Fringes
BECKHAM, CADDO, CARTER, COMANCHE, COTTON, CUSTER, DEWEY, GARVIN, GRADY, GREER, HARMON, JACKSON, JEFFERSON, JOHNSTON, KIOWA, LOVE, MARSHALL, PONTOTOC, ROGER MILLS, STEPHENS, TILLMAN AND WASHITA COUNTIES		
BRICKLAYERS & STONEMASONS	15.85	3.03

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BROK0005R 06/01/1995		
	Rates	Fringes
ALFALFA, BLAINE, ELLIS, GARFIELD, GRANT, HARPER, KINGFISHER, MAJOR, WOODS AND WOODWARD COUNTIES		
BRICKLAYERS & STONEMASONS	16.47	2.83

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BROK0005S 06/01/1995		
	Rates	Fringes
KAY AND NOBLE COUNTIES		
BRICKLAYERS & STONEMASONS	15.95	3.05

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CARP0329G 06/01/1997		
	Rates	Fringes

BECKHAM, BLAINE, CADDO, COMANCHE, COTTON, DEWEY, GARVIN (Remain-  
der of County), GRADY, GREER, HARMON, JACKSON, JEFFERSON,  
KINGFISHER (South of the Cimmaron River), KIOWA, STEPHENS,  
TILLMAN AND WASHITA COUNTIES

CARPENTERS & POWER SAW

OPERATORS	15.50	2.80
MILLWRIGHTS & PILEDRIVERMEN	16.90	2.80

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CARP1362C 01/01/1995

	Rates	Fringes
CARTER, GARVIN ( Northern half of Garvin including the Towns of Pauls Valley and Wynnwood), JOHNSTON, LOVE, MARSHALL, MURRAY AND PONTOTOC COUNTIES		

CARPENTERS	13.40	2.85
PILEDRIVERMEN	13.65	2.85
MILLWRIGHTS	15.50	2.85

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CARP1686D 06/11/1994

	Rates	Fringes
NOBLE COUNTY (East of Interstate #35 and South of Black Bear Creek)		

CARPENTERS	14.40	.80
MILLWRIGHTS	15.05	.80
PILEDRIVERMEN	14.40	.80
POWER SAW OPERATOR	14.40	.80

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CARP1894A 06/01/1993

	Rates	Fringes
ELLIS, HARPER, ROGER MILLS, WOODS AND WOODWARD COUNTIES		

CARPENTERS	11.55	1.40
MILLWRIGHTS	12.425	1.40
PILEDRIVERMEN	12.425	1.40
POWER SAW OPERATOR	11.85	1.40

-----  
CARP2008A 06/01/1994

	Rates	Fringes
ALFALFA, GARFIELD, GRANT, KAY, MAJOR, NOBLE (West of Interstate # 35 and North of Black Bear Creek) COUNTIES		

CARPENTERS, MILLWRIGHTS AND PILEDRIVERMEN	12.30	.30
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CARP2008B 06/01/1994

	Rates	Fringes
ALFALFA, GARFIELD, GRANT AND MAJOR COUNTIES		

LATHERS	12.30	.30
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ELEC0059G 06/01/1998

	Rates	Fringes
MARSHALL COUNTY		
ELECTRICIANS	18.90	2.20+11%

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ELEC0444B 12/01/1995

	Rates	Fringes
KAY AND NOBLE COUNTIES		
ELECTRICIANS	17.65	4.05+3.5%

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11/20/1998

ELEC0590A 06/01/1998

	Rates	Fringes
COMANCHE, COTTON, GREER, HARMON, JACKSON, JEFFERSON, KIOWA, STEPHENS AND TILLMAN		
ELECTRICIANS	16.45	4.05+3.5%

ELEC1002B 07/01/1996

	Rates	Fringes
LINE CONSTRUCTION:		
Lineman	21.53	2.00+16-1/4%
Cable Splicer	23.25	2.00+16-1/4%
Hole Digger, Heavy Equipment Op., (Pole Cat Equivalent)	19.16	2.00+16-1/4%
Powderman	18.52	2.00+16-1/4%
1.75+9%		
Line Truck Driver (Winch op.)	16.79	2.00+16-1/4%
Truck Driver (Flat Bed, Ton & 1/2) and Under)	14.43	2.00+16-1/4%
Jackhammer Op.	15.07	2.00+16-1/4%
Groundman	13.56	2.00+16-1/4%

ELEC1141E 06/01/1998

	Rates	Fringes
ALFALFA, BECKHAM, BLAINE, CADDO, CARTER, CUSTER, DEWEY, ELLIS, GARFIELD, GARVIN, GRADY, GRANT, HARPER, JOHNSON, KINGFISHER, LOVE, MAJOR, MURRY, PONTOTOC, ROGER MILLS, WASHITA, WOODS AND WOODWARD COUNTIES		
ELECTRICIANS	18.87	10-1/4%+2.50

ELEC1141G 09/01/1993

	Rates	Fringes
ALFALFA, BECKHAM, BLAINE, CADDO, CARTER, CUSTER, DEWEY, ELLIS, GARFIELD, GARVIN, GRADY, GRANT, HARPER, JOHNSON, KINGFISHER, LOVE, MAJOR, MURRAY, PONTOTOC, ROGER MILLS, WASHITA, WOODS AND WOODWARD COUNTIES		
ELECTRICIANS:		
Sound & Communication Technicians	14.25	4%

ELEV0063C 04/01/1998

	Rates	Fringes
ELEVATOR CONSTRUCTORS:		
Mechanic	18.815	6.405+a

FOOTNOTE:

a. Paid Holidays: New Year's Day; Memorial Day; July 4th; Labor Day; Thanksgiving Day; Friday after Thanksgiving Day; Christmas Day., Vacation Pay Credit: Employer contributes 8% of the basic hourly rate for employees with 5 years or more of service or 6% of the basic hourly rate for employees with 6 months to 5 years of service.

ENGI0627I 06/01/1995

	Rates	Fringes
POWER EQUIPMENT OPERATORS:		

GROUP 1:	17.80	4.85
GROUP 2:	17.30	4.85
GROUP 3:	16.80	4.85
GROUP 4:	16.55	4.85
GROUP 5:	15.05	4.85
GROUP 6:	15.80	4.85
GROUP 7:	15.40	4.85
GROUP 8:	13.80	4.85
GROUP 9:	13.30	4.85
GROUP 10:	12.80	4.85

GROUP 1: All crane type equipment with at least 300 feet of boom and over (including jib)

GROUP 2: All crane type equipment with at least 200 feet and less than 300 feet of boom (including jib)

GROUP 3: All crane type equipment with at least 100 feet and less than 200 feet of boom (including jib); all tower cranes; crane equipment (as rated by mfg.) 3 cu. yd. and over; guy derrick; whirley; power driven hole digger (with 30 feet and longer mast)

GROUP 4: Cranes with less than 100 feet of boom with jib and cranes (as rated by mfg.) less than 3 cu. yd.; heavy duty mechanic; overhead monorail type crane; panel board batch plant op.; piledriver engineer; dragline; clamshell; backhoe (3/4 yd. and over); sideboom or similar type equipment; gradall; cherry picker; hoist (while operating two or more drums); all hoist (while doing stack and chimney work); power driven hole digger with less than 30 ft. mast; motor patrol (boom type)

GROUP 5: Dozer (engine r.p. 65 or over); roller and compactors with dozer blade; backhoe under 3/4 yd., all scraper type equipment; water wagons under the jurisdiction of this craft; loader of hi-lift (engine h.p. 65 or over); asphalt laying machine; conveyor-multiple, panel board central; trenching machine; concrete pump (boom type)

GROUP 6: Rollers, all types; oil distributor; pulvimixer; screed operator; concrete pump (trailer type); rotary drilling machine when operated from console; greaser; tilt top trailer operator.

GROUP 7: Greaser; tilt top trailer operator

GROUP 8: Locomotive engineer; boring machine; tug boat; mixer - 18 cu. ft. and over; sand barge; dredging machine; tugger; hoist (operating one drum); air compressor - 3 to 6 - size 500 cu. ft. and under; air compressor - over 500 cu. ft. (1); pump, battery - 3 to 6; all fork-lift, bobcat and similar equipment; generator plant engineer, diesel elect; winch truck with A frame; concrete buster buster or tamper; heater under jurisdiction of operating engineers; fireman; boiler operator; crushing plants;

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farm tractor with or without attachments; batch plant operator - (portable); conveyor operator - continuous belt bulking handling; form grader; screening plant; well point pump operator; signal man on whirley when and if required; outside, side elevator or construction type hoist personel.

GROUP 9: Concrete mixers, less than 18 cu. ft.; air compressor, 500 cu. ft. and under (1 or 2); fuelman; asphalt lay machine backend man.

GROUP 10: Truck crane oiler and driver; crane oiler; permanent building type elevator operator.

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 IRON0048B 06/01/1997

	Rates	Fringes
BLAINE, CADDO, CARTER, COMANCHE, CUSTER, DEWEY, GARFIELD, GARVIN, GRADY, JOHNSTON, KINGFISHER, KIOWA, MAJOR, MURRAY, NOBLE, PONTOTOC, ROGER MILLS, STEPHENS, WASHITA AND WOODWARD COUNTIES		
IRONWORKERS	16.00	6.57

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IRON0263F 06/01/1997

	Rates	Fringes
MARSHALL COUNTY		
IRONWORKERS	15.00	3.75

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\* IRON0263G 06/01/1998

	Rates	Fringes
BECKHAM, COTTON, ELLIS, GREER, HARMON, HARPER, JACKSON JEFFERSON, LOVE AND TILLMAN COUNTIES		
IRONWORKERS	15.04	3.75

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IRON0584H 06/01/1997

	Rates	Fringes
KAY COUNTY (The southern portion to a line running east and west at the South City limits of Ponca City),		
IRONWORKERS	16.00	6.57

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\* IRON0606D 06/01/1998

	Rates	Fringes
ALFALFA, GRANT, KAY (Remainder of County), AND WOODS COUNTIES		
IRONWORKERS	15.55	5.09

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LABO0462C 06/01/1993

	Rates	Fringes
JOHNSTON, KAY, NOBILE AND PONTOTOC COUNTIES		
LABORERS:		
GROUP 1	8.00	1.31
GROUP 2	8.50	1.31
ALFALFA, BECKHAM, BLAINE, CADDO, CARTER, COMANCHE, COTTON, CUSTER, DEWEY, ELLIS, GARFIELD, GARVIN, GRADY, GRANT, GREER, HARMON, HARPER, JACKSON, JEFFERSON, KINGFISHER, KIOWA, LOVE, MAJOR, MARSHALL, MURRAY, ROGER MILLS, STEPHENS, TILLMAN, WASHITA, WOODS AND WOODWARD COUNTIES		

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LABORERS:

GROUP 1	7.50	1.31
GROUP 2	8.00	1.31

LABORER CLASSIFICATION

GROUP 1 - All digging and dirt work; Firing of salamanders and portable space heaters; All loading and unloading of the materials and equipment to and from hoist or cages for stock piling only; Wheeling and placing of concrete; Handling of lumber, steel, cement and distribution of materials; All cleaning including windows; All wrecking and razing of buildings and all structures; Cleaning and clearing of debris; Loading and unloading of materials, hoist or cages, except when the man is directly tending lathers, masons or plasterers; Water boys when used; Carpenters tenders.

GROUP 2 - All machine tool operators that come under the jurisdiction of the laborers; All sewer and drain tile layers and handling at the ditch, excluding distribution; Operators of water pumps up to four inches and slip form jackets; All men erecting scaffolds and directly tending lathers, masons, cement masons and plasterers, Mortar mixers, hod carriers and dry mixers; High work over 30 feet from ground or floors; Cement finisher tender; Work on swinging scaffold; All kettle and pot men; Tank cleaning; All pipe doping, treating and wrapping including all men working with dope; Mortar and plaster mixing machine pumpcrete machine and gunite mixing machines; including placing of concrete; Handling creosoted or treated materials liquid acid or like materials when injurious to health, eyes, skin or clothes; All newly developed mechanical equipment which replaces wheelbarrows or buggies previously used by loaders; All scale men on batch plants and tool crib men; All laborers screening sand, running sand drier and feeding operating sand blaster, except nozzle; Flaggers; Concrete graders and cutting torch operators in connection with laborers' work.

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PAIN0650B 05/15/1993

	Rates	Fringes
CARTER, COMANCHE, COTTON, GREER, HARMON, JACKSON, JEFFERSON, JOHNSTON, KIOWA, LOVE, MARSHALL, PONTOTOC, STEPHENS AND TILLMAN COUNTIES		

PAINTERS:

BRUSH & ROLLER	9.90	1.03
BRUSH & ROLLER (STRL. STEEL)	10.15	1.03
SPRAY	10.55	1.03
SWING STAGE, BOSUN CHAIR)	10.15	1.03
TAPING & BEDDING (HAND TOOLS)	10.20	1.03
SANDBLASTING	10.25	1.03

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PAIN0807A 05/01/1997		
	Rates	Fringes
REMAINING COUNTIES		
PAINTERS:		
Brush & Roller	13.55	2.53
Spray under 30 ft.	14.05	2.53
Spray over 30 ft.	14.55	2.53
Paper Hanging	14.55	2.53
Tapers using machine tools	14.05	2.53
PLAS0690B 06/01/1985		
	Rates	Fringes
JOHNSTON AND MARSHALL COUNTIES		
CEMENT MASONS	13.70	.76
PLAS0786A 06/01/1993		
	Rates	Fringes
KAY COUNTY		
CEMENT MASONS	10.80	
POWER TOOL OP.	11.05	
PLAS0807A 06/01/1990		
	Rates	Fringes
ALFALFA, BECKHAM, BLAINE, CADDO, CARTER, COMANCHE, COTTON, CUSTER, DEWEY, ELLIS, GARFIELD, GARVIN, GRADY, GRANT, GREER, HARMON, HARPER, JACKSON, JEFFERSON, JOHNSTON, KINGFISHER, KIOWA, LOVE, MAJOR, MARSHALL, MURRAY, NOBLE, ROGER MILLS, STEPHENS, TILLMAN, WASHITA, WOODS AND WOODWARD COUNTIES		
PLASTERERS	15.60	.95
PLUM0344F 07/01/1998		
	Rates	Fringes
REMAINING COUNTIES		
PLUMBERS, PIPEFITTERS	19.50	5.90
PLUM0767D 07/01/1997		
	Rates	Fringes
KAY COUNTY		
PLUMBERS, PIPEFITTERS	18.03	5.60
ROOF0143A 06/01/1998		
	Rates	Fringes
ROOFERS	14.50	3.20
SHEE0124A 07/01/1998		
	Rates	Fringes
SHEET METAL WORKERS (Including Duct Work)	19.76	5.07
TEAM0516A 06/01/1993		
	Rates	Fringes
MARSHALL COUNTY:		
TRUCK DRIVERS:		
GROUP 1:	10.43	
GROUP 2:	10.53	



GROUP 3:	10.63
GROUP 4:	10.58
GROUP 5:	10.73

#### TRUCK DRIVER CLASSIFICATIONS

GROUP 1 - Pick-up, 1-1/2 tons or 2-1/2 yards and up to but not including 3 tons or 4 yards, such as dump trucks, flat beds, stake bodies and buses.

GROUP 2 - 3 tons or 4 yards and up to but not including 4 tons or 6 yards.

GROUP 3 - 5 tons or 6 yards and over including heavy equipment such as pole trucks, winch trucks, euclids, mississippi wagons, semi-dumps, turner pulls or other heavy material moving equipment, tractor trailer drivers and similar equipment such as tractors, ten wheelers.

GROUP 4 - Ready mix concrete trucks up to but not including 3 yards and over.

GROUP 5 - Ready mix concrete truck 3 yards and over.

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TEAM0523A 06/01/1993

	Rates	Fringes
KAY AND NOBLE COUNTIES		
TRUCK DRIVERS:		
GROUP 1:	12.80	
GROUP 2:	12.85	
GROUP 3:	12.95	

#### TRUCK DRIVER CLASSIFICATION

GROUP 1 - Truck Drivers, Including pick-up, 1- 1/2 tons to 2-1/2 yards up to but not including 3 tons or 4 yards, such as dump trucks, flat beds, stake body or bus driver.

GROUP 2 - 3 tons or 4 yards up to but not including 4 tons or 6 yards.

GROUP 3 - Ready mix concrete truck, tractor trailer and similar equipment.

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TEAM0886A 06/01/1980

	Rates	Fringes
TRUCK DRIVERS:		
ALFALFA, BECKHAM, BLAINE, CADDO, CARTER, COMANCHE, COTTON, CUSTER, DEWEY, ELLIS, GARFIELD, GARVIN, GRADY, GRANT, GREER, HARMON, HARPER, JACKSON, JEFFERSON, JOHNSTON, KINGFISHER, KIOWA, LOGAN, LOVE, MAJOR, MURRAY, PONTOTOC, ROGER MILLS, STEPHENS, TILLMAN, WASHITA, WOOD AND WOODWARD COUNTIES.		
TRUCK DRIVERS:		
GROUP 1:	9.70	
GROUP 2:	9.40	
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## TRUCK DRIVER CLASSIFICATION

GROUP 1 - Truck Drivers for heavy equipment such as lowboys, heavy winch and floats, heavy earth moving equipment such as dump trucks and euclids.

GROUP 2 - Truck Drivers and swamper, such as dump trucks, flat beds, stakebodies and 3/4 and 1/2 ton pick-up trucks.

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WELDERS - Receive rate prescribed for craft performing operation to which welding is incidental.

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Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29 CFR 5.5(a)(1)(v)).

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In the listing above, the "SU" designation means that rates listed under that identifier do not reflect collectively bargained wage and fringe benefit rates. Other designations indicate unions whose rates have been determined to be prevailing.

## WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

- \* an existing published wage determination
- \* a survey underlying a wage determination
- \* a Wage and Hour Division letter setting forth a position on a wage determination matter
- \* a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour Regional Office for the area in which the survey was conducted because those Regional Offices have responsibility for the Davis-Bacon survey program. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations  
Wage and Hour Division  
U. S. Department of Labor  
200 Constitution Avenue, N. W.  
Washington, D. C. 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator

(See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator  
U.S. Department of Labor  
200 Constitution Avenue, N. W.  
Washington, D. C. 20210

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board  
U. S. Department of Labor  
200 Constitution Avenue, N. W.  
Washington, D. C. 20210

4.) All decisions by the Administrative Review Board are final.  
END OF GENERAL DECISION



US Army Corps  
of Engineers  
Tulsa District

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Fort Sill, Oklahoma

# **Whole Barracks Complex Renewal**

## **Project Specifications Volume II of V**

October 1998

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## SECTION 01040

## COORDINATION, FIELD ENGINEERING, AND MEETINGS

## 1 GENERAL

## 1.1 INSTALLATION OF CULVERTS AT MOW-WAY AND CURRIE ROADS

Contractor shall notify contracting Officer 30 days prior to installing culverts.

Culverts shall be installed concurrently.

If the Contractor chooses to install the culverts over a weekend, he may close Mow-way and Currie Roads where the culverts are being installed only from Friday at 6:00 p.m. to Monday at 6:00 a.m. As a minimum, he shall demolish the existing culvert at Mow-Way Road, install culverts at both roads and provide temporary asphalt surfacing at both roads. A shoofly shall be constructed if work cannot be completed by 6:00 a.m. on Monday. Additional work associated with the construction of the culverts shall be completed within 30 continuous days beginning Friday at 6:00 p.m.

If the Contractor chooses to install the culverts and complete associated work over a longer period of time, he shall construct a shoofly around the areas where the culverts are being installed. Maximum installation time for the culverts shall be 30 continuous days.

Regardless of the construction period chosen, Contractor shall provide for two-way traffic and erect appropriate traffic control devices during the installation of the culverts and completion of associated work.

## 1.2 UTILITY OUTAGE COORDINATION

## 1.2.1 Approval

The Contractor shall obtain written permission/approval from the Contracting Officer 21 days prior to:

- (1) Performing any work which will close any runway or street or interrupt any utility service.
- (2) Making any excavation: Any damage to underground utilities, communication lines, etc, will be the responsibility of the Contractor if the approval is not obtained.
- (3) Utility outages: The proposed outage request shall indicate the proposed work and length of outage.

## 1.2.2 Government Right to Delay

The Government reserves the right to postpone for 7 days, any scheduled outages. There shall be no outages when the outside temperature is expected to be below 2 degrees C.

### 1.2.3 Government Performance

Government personnel shall perform all shutting off and turning on of valves and switches necessary to accomplish scheduled outage.

## 1.3 QUANTITY SURVEYS (APR 1984) (FAR 52.236-16)

### 1.3.1 General

Quantity surveys shall be conducted, and the data derived from these surveys shall be used in computing the quantities of work performed and the actual construction completed and in place.

### 1.3.2 Conducting Surveys and Computations

The Contractor shall conduct the original and final surveys and surveys for any periods for which progress payments are requested. All these surveys shall be conducted under the direction of a representative of the Contracting Officer, unless the Contracting Officer waives this requirement in a specific instance. The Government shall make such computations as are necessary to determine the quantities of work performed or finally in place. The Contractor shall make the computations based on the surveys for any periods for which progress payments are requested.

### 1.3.3 Submittals

Promptly upon completing a survey, the Contractor shall furnish the originals of all field notes and all other records relating to the survey or to the layout of the work to the Contracting Officer, who shall use them as necessary to determine the amount of progress payments. The Contractor shall retain copies of all such material furnished to the Contracting Officer.

## 1.4 LAYOUT OF WORK (APR 1984) (FAR 52.236-17)

The Contractor shall lay out his work from Government-established base lines and bench marks indicated on the drawings and shall be responsible for all measurements in connection with the layout. The Contractor shall furnish, at his own expense, all stakes, templates, platforms, equipment, tools, and materials and labor required to lay out any part of the work. The Contractor shall be responsible for executing the work to the lines and grades that may be established or indicated by the Contracting Officer. The Contractor shall also be responsible for maintaining and preserving all stakes and other marks established by the Contracting Officer until authorized to remove them. If such marks are destroyed by the Contractor or through his negligence before their removal is authorized, the Contracting Officer may replace them and deduct the expense of the replacement from any amounts due or to become due to the Contractor.

Additional information pertaining to horizontal control data is included at the back of this section.

## 2 PRODUCTS (NOT APPLICABLE)

## 3 EXECUTION (NOT APPLICABLE)

## SECTION 01100

## SAFETY

## 1 GENERAL

## 1.1 SAFETY AND HEALTH REQUIREMENTS MANUAL (EM 385-1-1, SEPTEMBER 1996).

In accordance with CONTRACT CLAUSE Paragraph "ACCIDENT PREVENTION", this manual applies to all work under this contract. There are submittals and testing required by this manual which require Government Approval (GA) before certain phases of work can begin.

## 1.2 MANAGEMENT OF CONTRACTOR-GENERATED HAZARDOUS WASTES AND PETROLEUM PRODUCTS (40 CFR, PART 262)

Contractors generating hazardous wastes and petroleum products on the military base on which this contract is performed shall be responsible for their management responsibilities as described in 40 CFR, part 262 and with the Oklahoma State Industrial Waste Management Regulations.

## 1.3 MONTHLY EXPOSURE REPORT

A monthly report of accident and exposure data shall be submitted by the Contractor. The report shall be submitted on SWD Form 743-J "MONTHLY EXPOSURE REPORT OF OPERATIONS AND ACTIVITIES" which will be provided to the Contractor at the pre-construction conference.

## 1.4 ACCIDENT PREVENTION PREPLANNING (SWTCD)

In addition to the requirements of the CONTRACT CLAUSE entitled "Accident Prevention," the Contractor shall:

a. Meet with the Contracting Officer and/or his representative before each major phase of construction. The purpose of the meeting will be to identify the specific hazards that are associated with that phase of construction. The meeting will include the general Contractor's superintendent, Quality Control Inspector, and superintendent or foreman in charge of the operation whether performed by the general Contractor or subcontractor.

b. Identify at this meeting what construction methods and equipment will be used to protect the workmen against the hazards that are anticipated during that phase of construction. This plan, when agreed upon by the Contracting Officer and Contractor, will become a part of the Contractor's safety program.

c. Be responsible for insuring that all subcontractors are knowledgeable and follow the safety plan agreed upon by the Contractor and Contracting Officer.

## 1.5 RADIATION SOURCE COORDINATION

The Contractor shall coordinate with the Contracting Officer at least seven days prior to bringing any radiation source onto an Army installation.

## 1.6 CONTRACTOR SAFETY PERSONNEL REQUIREMENT

- a. Full-time, on-site, safety coverage shall be provided by the Contractor.
- b. The following conditions shall be met:
  - (1) The Contractor shall employ at the project site to cover all hours of work at least one Safety and Occupational Health person to manage the Contractor's accident program. Duties which are not applicable to the safety program shall not be assigned to the same. The principal safety person shall report to and work directly for the Contractor's on-site top manager, higher level official, or corporate safety office. The Safety and Health person(s) shall have the authority to take immediate steps to correct unsafe or unhealthful conditions. The presence of a Safety and Health person will not abrogate safety responsibilities of other personnel.
  - (2) Qualifications for Safety and Health person(s).
    - (a) Shall have a degree in engineering or safety in at least a four year program from an accredited school; or
    - (b) Shall have legal registration as a Professional Engineer or a Certified Safety Professional and, in addition, shall have been engaged in safety and occupational health for at least one year of experience, no time being credited to this one year unless at least fifty percent of the time was devoted to safety and occupational health; or
    - (c) Shall have a degree other than that specified in (a) above and , in addition, shall have been engaged in safety and occupational health for at least three years, no time being credited to these three years unless at least fifty percent of the time each year was devoted to safety and occupational health; or
    - (d) In lieu of a degree, shall have been engaged in safety and occupational health for at least five years, no time being credited to these five (5) years unless at least fifty percent of the time each year was devoted to safety and occupational health;
    - (e) First aid work is not a creditable experience.
  - (3) The name and qualifications of the nominated safety person(s) shall be furnished to the Contracting Officer for acceptability and a functional description of duties shall be provided prior to the pre-work conference.

2 PRODUCTS (NOT APPLICABLE)

3 EXECUTION (NOT APPLICABLE)



## SECTION 01200

PAYMENT  
(PERFORMANCE AWARD FEE)

## 1 GENERAL

## 1.1 PERFORMANCE AWARD FEE (PAF) PROVISIONS.

## 1.1.1 PAF Plan

This contract includes a Performance Award Fee (PAF) plan to maximize performance excellence by the Contractor. An amount of \$250,000.00 is established which the Contractor may earn under the provisions of the PAF plan.

## 1.1.2 Earning the PAF

The PAF may be earned by the Contractor in whole or in part. The amount of PAF earned shall be determined by the Government's subjective evaluation of the Contractor's performance during specified rating periods. Unearned PAF from any rating period may not be added to potential PAF for any subsequent rating period.

## 1.1.3 PAF Evaluation

The Government will perform an evaluation of the Contractor's performance according to the criteria set forth herein.

## 1.1.4 PAF Payment

Payment of the PAF shall be made after each rating period by the issuance of a unilateral change order setting forth the amount of PAF earned for the rating period and the subsequent submission of an invoice by the Contractor.

## 1.1.5 PAF Determination

The PAF decision shall be a unilateral determination made by the Government and shall not be subject to the CONTRACT CLAUSE entitled "Disputes".

## 1.1.6 Rating Periods

Five rating periods will be included for evaluation. An evaluation of Contractor performance will be performed upon the work specified in the Contract at the end of 25%, 50%, 75%, 100% of the in-place work specified in the contract and at the completion of the warranty period.

## 1.1.7 PAF Allocation

A portion of the total PAF which the Contractor may earn will be allocated to each rating period as scheduled in Table I at the end of the section.

## 1.1.8 Organization

The PAF organizations will consist of personnel within the Tulsa District Corps of Engineers and Fort Sill. The organization may change during the

course of the work; however, the basic responsibilities described herein shall continue during the term of the Contract.

#### 1.1.9 Responsibilities

##### 1.1.9.1 Contracting Officer (CO)

The CO is the person administering the Contract on behalf of the Government.

##### 1.1.9.2 Administrative Contracting Officer (ACO)

The ACO is a Government employee, selected and designated in writing, by the Contracting Officer to act as his representative in administering the contract. The ACO will evaluate the Contractor's performance within designated functional areas and perform other duties as authorized by the Contracting Officer.

##### 1.1.9.3 PAF Review Board (PAFRB)

Members of the PAFRB are designated personnel who review the recommended PAF submitted by the ACO. The board assures that the recommendations are consistent with available data. The board may submit changes to PAF recommendations to the PAF Determining Official (PAFDO). The designated members of the PAFRB are:

Chief, Engineering and Construction Division (Chairman)  
Chief, Military Branch, Programs and Projects Management Division  
Deputy Director of Public Works, Fort Sill

##### 1.1.9.4 Alternate members of the PAFRB

Alternate members shall be designees of the members listed above.

##### 1.1.9.5 PAF Determining Official (PAFDO)

The PAFDO is the designated official who determines the PAF to be paid to the Contractor based upon recommendations submitted by the PAFRB. The designated PAFDO is the Contracting Officer.

#### 1.1.10 PAF Process

The PAF earned by the Contractor for performance shall be determined at the rating period intervals specified above based upon evaluations of the Contractor's performance on the contract and PAF calculations. The Contractor shall submit after completion of each rating period, an evaluation and score of the Contractor's performance for that rating period. The ACO will review the Contractor's evaluation and scores and provide the Contractor with the ACO comments and evaluation of the Contractor's performance for the rating period. The ACO shall then prepare and forward to the PAFRB the necessary documentation for the PAFRB's evaluation and consideration of the recommended PAF. The PAFRB shall prepare and forward to the PAFDO the PAF Recommendation Report for approval, modification or disapproval.

#### 1.1.11 Performance Factors

Five performance factors will be evaluated. The performance factors which will be assessed and used for development of the recommended PAF are as follows. The percentages given indicate each Performance Factor's proportional weight of the overall construction evaluation.

##### 1.1.11.1 Construction Schedule (35%)

The Construction Schedule evaluation is based on the Contractor's effectiveness in planning and performing the required work in a timely manner. The following indicators will be used in evaluating the work.

- a. Submittal of a Realistic Construction Schedule--The Contractor shall be evaluated upon his ability to submit a realistic and complete construction schedule.
- b. Maintaining Construction Schedule--The Contractor shall be evaluated upon his ability to adhere to the construction schedule.
- c. Updating Construction Schedule--The Contractor shall be evaluated upon his timely and proper submission of realistic updates to the construction schedule.

##### 1.1.11.2 Construction Management (30%)

Construction Management evaluation is based on the Contractor's overall management of the contract to include but not limited to modifications, submittals, response to Government direction, early identification of problems, subcontractor management, continuous documentation of construction changes for as-built documents, continuous assembling of O&M manuals, etc. These indicators will be monitored to evaluate Construction Management.

##### 1.1.11.3 Quality Control (20%)

Quality Control evaluation is based on the method by which the Contractor develops and monitors the overall quality control (QC) effort. This includes evaluating the staffing and utilization of resources to implement the QC system and the efficiency and effectiveness of the system. The following indicators will be monitored in order to evaluate quality control.

- a. Work performed in accordance with the scope of work.
- b. Proper QC report documentation.
- c. Implementing corrective actions.

##### 1.1.11.4 Safety (15%)

Safety evaluation is based on the Contractor's compliance with applicable health and safety requirements and the Contractor's applied knowledge of proper health and safety techniques. Evaluation is conducted on all aspects of work related to health and safety including performance of personnel assigned to the project, initiating corrective actions, and accident reporting. Safety is worth ten percent (15%) of the overall evaluation. The following activities will be specifically evaluated although any work activity may be evaluated for health and safety aspects.

- a. Lost time accidents.
- b. Work performed in accordance with Corps of Engineers Safety Manual (EM 385-1-1).

#### 1.1.11.5 Warranty

Warranty evaluation will be based on the effectiveness of the Contractor in resolving warranty issues and the timely and correct submittal of **completed as-built** drawings and **completed** O&M manuals.

#### 1.1.12 Rating

Each evaluation will be subjectively assigned an adjective and numerical rating for each rating period. The adjective rating, numerical rating, and their corresponding description are set forth in Table II at the end of the section.

#### 1.1.13 PAF Computation

The following is the computational process to calculate the PAF amount for each rating period:

- a. Determine Rating Period and the corresponding PAF Allocation for that period.
- b. Evaluate Performance for each Performance Factor
- c. Assign Numerical Rating to each Performance Factor
- d. Determine each Performance Factor Weighted Score : Multiply Numerical Rating by Performance Factor Weight. Total all weighted scores
- e. Convert Total Weighted Score to a PAF Percentage
- f. Calculate PAF earned by multiplying PAF Allocation by PAF Percentage

#### 1.1.14 PAFDO Discretion

The PAF scores are advisory in nature and will serve as guidelines to the PAFDO. The PAFDO has broad discretion, consistent with this plan, to incorporate a subjective judgement into the process. While the PAFDO cannot disregard the results of the scoring system, the official is not bound to strictly follow the results if other considerations override.

#### 1.1.15 Weighted Score/PAF Percentage Conversion Chart

The Total Weighted Score shall be converted to a Percentage Value in accordance with Table III at the end of the section.

- 2 PRODUCTS (NOT USED)
- 3 EXECUTION (NOT USED)

## COMPUTATION EXAMPLE

Total PAF Amount: \$250,000 (Par 1.1.1)

Rating Period: 25% (Percent of work complete) (Par 1.1.6)

PAF Allocation: \$37,500 (15% of total PAF) (See Table I)

Total Weighted Score 88.75 (Determined as shown below) (See Table II)

Performance Factor	Performance Factor Weight	Numerical Rating	Weighted Score
Construction Schedule	35%	90	31.50
Construction Management	30%	85	25.50
Quality Control	20%	95	19.00
Safety	15%	85	12.75
Total Weighted Score			88.75

Total PAF Amount: \$250,000 (Par 1.1.1)

PAF Percentage 63% (See Table III)

PAF Earned: \$23,625 ( PAF Allocation x PAF Percentage)

<u>TABLE I</u>	
<u>Rating Period</u> <u>(%Complete)</u>	<u>PAF Allocation</u> <u>(% of Total</u> <u>PAF)</u>
25	15
50	15
75	25
100	35
End of Warranty Period	10

TABLE II

<u>ADJECTIVE</u> <u>RATING</u>	<u>NUMERICAL</u> <u>RATING</u>	<u>DESCRIPTION</u>
Outstanding	100	Performance is uniformly well above standards. Self-initiated, innovative management techniques have resulted in superior quality, timeliness, and effective operations.
Excellent	90-99	Performance in most areas is well above standards while the remaining efforts meet contract requirements.
Good	80-89	Performance in some areas is well above standards while some areas meet contract requirements.
Above Satisfactory	71-79	Performance in most areas meets standards, with the few remaining areas exceeding standards.
Satisfactory	70 and below	Meets minimum standards.

TABLE III

<u>Weighted Score</u>	<u>PAF Percentage</u>
100	100
99	97
98	93
97	90
96	87
95	83
94	80
93	77
92	73
91	70
90	67
89	63
88	60
87	57
86	53
85	50
84	47
83	43
82	40
81	37
80	33
79	30
78	27
77	23
76	20
75	17
74	13
73	10
72	7
71	3
70 or below	0

## SECTION 01300

## SUBMITTAL PROCEDURES

## 1 GENERAL

## 1.1 SHOP DRAWINGS

## 1.1.1 General

Shop drawings shall conform to requirements of CONTRACT CLAUSE entitled "Specifications and Drawings for Construction." The Contractor shall submit to the Contracting Officer for approval five copies of all shop drawings as called for under the various headings of these specifications. Three sets of all shop drawings will be retained by the Contracting Officer and one set will be returned to the Contractor. Submittals shall include items such as: Contractor's, manufacturer's, or fabricator's drawings; descriptive literature including (but not limited to) catalog cuts, diagrams, operating charts or curves; test reports; test cylinders; samples; O&M manuals including parts list; certifications; warranties and other such required submittals. Submittals requiring Government approval shall be scheduled and made prior to the acquisition of the material or equipment covered thereby.

## 1.1.2 Review and Approval of Shop Drawings and Samples

The Contractor shall submit all items as required in the other sections of these specifications. The Contracting Officer may request submittals in addition to those specified when deemed necessary to adequately describe the work required. Units of weights and measures used on all submittals shall be the same used in the contract drawings. Each submittal shall be complete and in sufficient detail to allow ready determination of compliance with contract requirements. Prior to submittal, all items shall be checked and approved by the Contractor's Quality Control (CQC) representative and each respective transmittal shall be stamped, signed, and dated by the CQC representative certifying that the accompanying submittal complies with the contract requirements.

## 1.1.3 Approval Stamp

Approval by the Contractor shall be accomplished by stamping shop drawings with a stamp with information similar to the following:



_____ Approved
_____ Approved with corrections as noted on submittal data and/or attached sheets(s).
SIGNATURE: _____
TITLE: _____
DATE: _____

## 1.2 TRANSMITTAL FORM (ENG FORM 4025)

Transmittal Form (ENG Form 4025) shall be used for submitting submittals in accordance with the instructions on the reverse side of the form. (See sample Form 4025 at the end of this section) These forms will be furnished to the Contractor as needed. This form shall be properly completed by filling out all the heading blank spaces and identifying each item submitted. The specification paragraph or sheet number of the contract drawings pertinent to the data submitted shall be provided for each item. All samples of materials submitted as required by these specifications shall be properly identified and labeled for ready identification, and upon being approved, stored at the site of the work for jobsite use until all work has been completed and accepted by the Contracting Officer.

All proposed deviations requested by the Contractor shall be noted in the "Remarks" column of the ENG Form 4025. The Contractor shall set forth in writing the reason for any deviations and annotate such deviations on the shop drawing. The Government reserves the right to rescind inadvertent approval of shop drawings containing unnoted deviations.

## 1.3 SUBMITTAL REGISTER (ENG FORM 4288)

### 1.3.1 Preparation

A Submittal Register as shown at the end of this section shall list all items required by the specifications to be submitted to the Government. The list shall include shop drawings, tests, certificates, computations, and all other items specified to be submitted to the Contracting Officer except safety plans, quality control plans, environmental plans, and routine quality control tests. The listing shall give the page and paragraph number of the specifications for each item listed and the Contractor Scheduled Dates.

The technical specification sections shall be referenced for complete submittal requirements. The Contractor shall complete the form and return the completed form to the Contracting Officer for approval. The approved Submittal Register will become the scheduling document and will be used to control submittals throughout the life of the contract. This register and the progress schedules shall be coordinated.

Submittals covering component items forming a system or items that are interrelated shall be scheduled to be coordinated and submitted concurrently. All various types of submittals for each item (i.e. data, drawings, instructions, certifications, etc.) shall be submitted concurrently. Adequate time, but not less than 30 days, shall be allowed on the Submittal Register for review and approval by the Government of all submittals. Delays, damages, or time extensions will not be allowed for time lost due to late submittals.

#### 1.3.2 Submittal and Maintenance of Submittal Register

##### 1.3.2.1 Initial Submittal

The Submittal Register shall be submitted within 21 days after notice to proceed.

##### 1.3.2.2 Register Maintenance

The Contractor shall maintain the Submittal Register listing all submittals as the items are submitted. Listings shall be grouped by section number and listed in numerical sequence of the Transmittal Number shown on Form 4025. When the project is 90 percent complete, the up-to-date, typed Form shall be submitted to the Contracting Officer for review to assure that required submittals and resubmittals have been noted.

##### 1.3.2.3 Final Submittal

Upon completion of the work the completed Submittal Register shall be submitted to the Contracting Officer.

#### 1.4 SUBMITTAL CLASSIFICATION

Submittals are classified as follows:

##### 1.4.1 Government Approved (GA)

Governmental approval is required for extensions of design, critical materials, deviations, equipment whose compatibility with the entire system must be checked, and other items as designated by the Contracting Officer. Within the terms of the Contract Clause entitled "Specifications and Drawings for Construction," they are considered to be "shop drawings." Upon completion of review of submittals requiring Government approval, the submittals will be identified as having received approval by being so stamped and dated. Three copies of the submittal will be retained by the Contracting Officer and one copy of the submittal will be returned to the Contractor.

#### 1.4.2 For Information Only (FIO)

All submittals not requiring Government approval will be for information only. They are not considered to be "shop drawings" within the terms of the Contract Clause referred to above.

#### 1.5 APPROVED SUBMITTALS

The approval of submittals by the Contracting Officer shall not be construed as a complete check, but will indicate only that the general method of construction, materials, detailing and other information are satisfactory. Approval will not relieve the Contractor of the responsibility for any error which may exist. After submittals have been approved by the Contracting Officer, no resubmittal for the purpose of substituting materials or equipment will be given consideration unless accompanied by an explanation as to why a substitution is necessary.

#### 1.6 DISAPPROVED SUBMITTALS

The Contractor shall make all corrections required by the Contracting Officer and promptly furnish a corrected submittal in the form and number of copies as specified for the initial submittal. If the Contractor considers any correction indicated on the submittals to constitute a change to the contract, notice as required under the Contract Clause entitled "Changes" shall be given promptly to the Contracting Officer.

#### 1.7 WITHHOLDING OF PAYMENT

Payment for materials incorporated in the work will not be made if required approvals have not been obtained.

#### 1.8 SUBMITTAL DESCRIPTIONS

The submittals described below are those required and further described in other sections of the specifications. Submittals required by the CONTRACT CLAUSES and other nontechnical parts of the contract are not included.

##### SD-01 Data

Submittals which provide calculations, descriptions, or documentation of the work.

##### SD-04 Drawings

Submittals which graphically show relationship of various components of the work, schematic diagrams of systems, details of fabrication, layouts of particular elements, connections, and other relational aspects of the work.

##### SD-06 Instructions

Preprinted material describing installation of a product, system or material, including special notices and material safety data sheets, if any, concerning impedances, hazards, and safety precautions.

## SD-07 Schedules

Tabular lists showing location, features, or other pertinent information regarding products, materials, equipment, or components to be used in the work.

## SD-08 Statements

A document, required of the Contractor, or through the Contractor, from a supplier, installer, manufacturer, or other lower tier Contractor, the purpose of which is to confirm the quality or orderly progression of a portion of the work by documenting procedures, acceptability of methods or personnel, qualifications, or other verifications of quality.

## SD-09 Reports

Reports of inspections or tests, including test methods used, test results, analysis and interpretation of test results.

## SD-13 Certificates

Statement signed by responsible official of a manufacturer of a product, system or material, attesting that the product, system or material meets specified requirements. The statement identifies the date of the certificate, name of the project, and list of the specific requirements which are being certified.

## SD-14 Samples

Samples, including both fabricated and unfabricated physical examples of materials, products, and units of work as complete units or as portions of units of work.

## SD-18 Records

Documentation to record compliance with technical or administrative requirements.

## SD-19 Operation and Maintenance Manuals

Data which forms a part of an operation and maintenance manual.

## 1.9 CONSTRUCTION COLOR BOARD (SWT-EC-EA, T. VERDEL)

## 1.9.1 Description

Contractor shall prepare in binder format a series of construction color boards which illustrate by means of physical samples the materials and finishes that are integral to the exterior and interior finishes of the completed facility. These items include, but are not limited to: masonry, architectural concrete, metal panels, siding and roofing, interior and exterior trim, paints, wall coverings, floor coverings and base, ceiling materials, plastic laminates, casework, stained woodwork, toilet partition and accessory finishes, etc. Color board samples (especially of exterior finish materials) are not required to be of full size or thickness but must represent the full range of color, texture, and finish of the materials.

Carpet samples shall not be less than 75 mm by 125 mm or larger if needed to indicate complete color and design.

#### 1.9.2 Format

Material samples shall be mounted on 8 1/2" x 11" modules with the project title and name of the installation placed in the lower right corner of each module. Sample board modules shall consist of protection (mat) boards of sufficient strength and thickness to support and anchor samples. Large or heavy samples shall be anchored with mechanical fasteners or epoxy resin cement. "Rubber cement" or other contact adhesives shall not be used 216 mm by 280 mm boards shall be three-hole punched and placed in 3-ring binders. 8-1/2" x 11" 216 mm by 280 mm boards may be securely taped together at edges to provide a "fold-out" display presentation provided overall dimensions of fold-out materials does not exceed 648 mm x 838 mm. Each 3-ring binder shall be identified on its spine with the following information: project fiscal year, project title, contract number, installation name where project is to be built and date of submittal (month and year). Presentation shall be organized in a logical manner to facilitate an orderly and speedy review. Sample items and color names shall be identified with names that correspond to names shown on the project color and finish schedule. If not readily apparent from the color and finish schedule, the sample boards shall be annotated to reflect what areas or surfaces of the facility are to receive the finishes shown.

#### 1.9.3 Submittal

Five complete sets of the construction color boards shall be submitted to the Contracting Officer for approval within 120 calendar days after Notice to Proceed. All other technical submittals regarding finish materials depicted on these boards (test reports, certifications, manufacturer's instructions or data sheets, etc.) as required by technical portions of this project specification, shall be submitted prior to or concurrent with the construction color boards.

#### 1.9.4 Approval

Upon receipt by the Contracting Officer of all finish material submittals (technical submittal materials and construction color boards) a 30-day review period by the Government shall be allowed. No finish work involving any item included on the color board shall be started by the Contractor prior to the approval of the total construction color boards. After receipt of final approval by the Government, the Contractor shall mark each approved item on the color board with its appropriate technical submittal transmittal number, make any corrections, additions or deletions required by the Government and return the five sets of approved construction color boards to the Contracting Officer. Any Contractor proposed substitutions of materials following approval must be approved by the Government as coordinating visually with other approved items equally as well as the originally approved item.

#### 1.10 WIRING AND CONTROL DIAGRAMS

The Contractor shall furnish one reproducible, unfolded copy of all wiring and control diagrams and approved system layout drawings with the operating instructions called for under the various headings of these specifications for mechanical and electrical systems.

## 1.11 EMCS, MECHANICAL EQUIPMENT, AND TEMPERATURE CONTROL SUBMITTAL COORDINATION

### 1.11.1 General

Submittals for temperature controls and mechanical equipment as specified in Division 15 and/or energy management control systems (EMCS) as specified in Division 13 shall be submitted in accordance with the procedure outlined below.

### 1.11.2 Procedure

Submittals shall be submitted as Groups with each group to include items scheduled below. All items in Group 3 shall be submitted together at the same time. All items in each group shall be submitted prior to submittal of any item in a subsequent package.

### 1.11.3 Approval

Items to be submitted which are required to receive Government Approval (GA) as specified in the specifications shall be approved prior to the submittal of any item in a subsequent group.

### 1.11.4 Group Descriptions

Submittals included in each group shall be for items listed in the following schedule:

#### GROUP 1

Control Valves Control Dampers Temperature control piping and other control\EMCS rough-in hardware VAV controllers (when not specified as a part of the VAV boxes)

#### GROUP 2

Mechanical equipment operated or associated with temperature controls and/or EMCS.

#### GROUP 3

Temperature controls and EMCS items including the following:

point-to-point wiring diagrams bills of materials sequences of operation (with reference to I/O summary for EMCS) hardware data sheets EMCS I/OS summaries, system schematics, installation details, and legend

Temperature controls shall be transmitted separate from the EMCS items.

### 1.11.5 Dual Function Items

Items which serve for both the temperature control systems and the EMCS system shall be submitted (and approved if GA) in accordance with the temperature control requirements. However, the appropriate corresponding EMCS information shall also be submitted for information only (FIO). This

information shall be listed separately as "Supplemental Reference" on the Transmittal Form.

2 PRODUCTS (NOT APPLICABLE)

3 EXECUTION (NOT APPLICABLE)





# DRILLED PIER RECORD

[illegible]

<sup>1</sup>Distance from ground surface to Casing \*\* Top of Casing above ground, top of Casing below ground  
<sup>2</sup>Clock Time beginning and end of indicated operation

CONTRACT NO.
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CONTRACTOR

**SPECIFICATION SECTION**

**01310**

[illegible]

CONTRACT NO.

CONTRACTOR

SPECIFICATION SECTION

**01561**

[illegible]

CONTRACT NO.

## TITLE AND LOCATION

CONTRACTOR

SPECIFICATION SECTION

**WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA**

02222

[illegible]

CONTRACT NO.
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CONTRACTOR

SPECIFICATION SECTION

**WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA**

**02225**

[illegible]

CONTRACT NO.

## TITLE AND LOCATION

CONTRACTOR

SPECIFICATION SECTION

**WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA**

**02230**

[illegible]

CONTRACT NO.

## TITLE AND LOCATION

CONTRACTOR

SPECIFICATION SECTION

**WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA**

02240

[illegible]

CONTRACT NO.

CONTRACTOR

SPECIFICATION SECTION

**WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA**

02241

[illegible]



CONTRACT NO.

CONTRACTOR

SPECIFICATION SECTION

**02285**

[illegible]

CONTRACT NO.

CONTRACTOR

SPECIFICATION SECTION

**02383**

[illegible]

CONTRACT NO.

## TITLE AND LOCATION

CONTRACTOR

SPECIFICATION SECTION

**WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA**

02511

[illegible]

CONTRACT NO.
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CONTRACTOR

**SPECIFICATION SECTION**

**02558**

[illegible]



SUBMITTAL REGISTER																							CONTRACT NO.		
(ER 415 1-10)																									
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WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA																					02660				
ACTIVITY NO a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL										CLASSIFICATION		CONTRACTOR SCHEDULE DATES			CONTRACTOR ACTION			GOVERNMENT ACTION		REMARKS aa.
					DRAWINGS f.	INSTALLATION g.	STANDARD h.	STANDARD i.	STANDARD j.	STANDARD k.	STANDARD l.	STANDARD m.	STANDARD n.	STANDARD o.	STANDARD p.	STANDARD q.	STANDARD r.	SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	DATE v.	SUBMIT TO GOVERNMENT w.	DATE x.	GOVERNMENT ACTION y.	

CONTRACT NO.

CONTRACTOR

SPECIFICATION SECTION

**WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA**

**02685**

[illegible]

CONTRACT NO.

## TITLE AND LOCATION

CONTRACTOR

SPECIFICATION SECTION

**WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA**

02698

[illegible]



CONTRACT NO.

CONTRACTOR

SPECIFICATION SECTION

02699

[illegible]

CONTRACT NO.

CONTRACTOR

SPECIFICATION SECTION

**02711**

[illegible]

CONTRACT NO.

CONTRACTOR

SPECIFICATION SECTION

02720

[illegible]

CONTRACT NO.

CONTRACTOR

SPECIFICATION SECTION

02811

[illegible]

CONTRACT NO.

CONTRACTOR

SPECIFICATION SECTION

**02870**

[illegible]

CONTRACT NO.
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CONTRACTOR

**SPECIFICATION SECTION**

**02935**

[illegible]

CONTRACT NO.

CONTRACTOR

SPECIFICATION SECTION

02950

[illegible]

CONTRACT NO.
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CONTRACTOR

**SPECIFICATION SECTION**

**03100**

[illegible]



SUBMITTAL REGISTER																							CONTRACT NO.			
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ACTIVITY NO a.	TRANSMITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL										CLASSIFICATION		CONTRACTOR SCHEDULE DATES			CONTRACTOR ACTION			GOVERNMENT ACTION		REMARKS aa.	
					DRAWINGS f.	INSTALLATION g.	STRUCTURES h.	STREET LIGHTS i.	CERVICES j.	ELECTRICAL k.	Pipes l.	Cable m.	Other n.	Information o.	General p.	Approval q.	Material r.	Submit s.	Approval t.	Material u.	Date v.	Submit w.	Date x.	Code y.		Date z.

CONTRACT NO.

**CONTRACTOR**

**SPECIFICATION SECTION**

**WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA**

**03250**

[illegible]

SUBMITTAL REGISTER																					CONTRACT NO.				
(ER 415 1-10)																									
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ACTIVITY NO a.	TRANSMITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL										CLASSIFICATION		CONTRACTOR SCHEDULE DATES			CONTRACTOR ACTION			GOVERNMENT ACTION		REMARKS aa.
					DRAWINGS f.	INSTRUMENTS g.	STANDARD h.	STANDARD i.	STANDARD j.	STANDARD k.	STANDARD l.	STANDARD m.	STANDARD n.	STANDARD o.	STANDARD p.	STANDARD q.	STANDARD r.	SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	DATE v.	SUBMIT TO GOVERNMENT w.	DATE x.	GOVERNMENT ACTION y.	

# SUBMITTAL REGISTER

(ER 415 1-10)

CONTRACT NO.

TITLE AND LOCATION

CONTRACTOR

SPECIFICATION SECTION

**WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA**

**03410**

ACTIVITY NO	TRANS-MITTAL NO.	ITEM NO	SPECIFICATION PARAGRAPH NUMBER	DESCRIPTION OF ITEM SUBMITTED	TYPE OF SUBMITTAL										CLASSI- FICATION		CONTRACTOR SCHEDULE DATES			CONTRACTOR ACTION			GOVERNMENT ACTION		REMARKS	
					DRAWINGS AND TAGS	INSTRUMENTS AND TESTS	STATEMENTS AND NOTES	CERTIFICATES AND TESTS	RECORDS AND TESTS	PERMITS AND TESTS	O & M REPAIRS AND TESTS	INFORMATION AND TESTS	GOVERNMENT REVIEW AND TESTS	SUBMIT			APPROVAL NEEDED BY	MATERIAL NEEDED BY	CODE	DATE	SUBMIT TO GOVERN- MENT	CODE	DATE			
a.	b.	c.	d.	e.	f.	g.	h.	i.	j.	k.	l.	m.	n.	o.	p.	q.	r.	s.	t.	u.	v.	w.	x.	y.	z.	aa.
			1.3	Anchorage and Lifting Inserts and Devices	X											X										
			1.3	Bearing Pads	X											X										
			1.3	Cast-in Embedded Items and Connectors	X											X										
			1.3	Connection Devices	X											X										
			1.3	Precast Concrete Members Design Calculations	X											X										
			1.3	Concrete Mix Design	X											X										
			1.3	Concrete Mix Design for Repair of Surface Defects	X											X										
			1.3	Precast Concrete Wall Panel	X											X										
				Connection and Embedment Design Calculations																						
			1.3	Drawings of Precast Members	X											X										
			1.3	Installation of Precast Concrete Wall Panel		X										X										
			1.3	Fabrication				X								X										
			1.3	Fly ash Test					X							X										
			1.3	Pozzolan Test					X							X										
			1.3	Ground Slag Test					X							X										
			1.3	Contractor-furnished Mix Design					X							X										
			1.3	Strength Tests					X							X										
			1.3	Surface Finish							X					X										
			1.3	Concrete Batch Ticket Information								X				X										

CONTRACT NO.
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CONTRACTOR

**SPECIFICATION SECTION**

**03412**

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CONTRACT NO.
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CONTRACTOR

SPECIFICATION SECTION

**WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA**

**03512**

[illegible]

CONTRACT NO.

**CONTRACTOR**

**SPECIFICATION SECTION**

## WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA

04200

[illegible]

SUBMITTAL REGISTER																				CONTRACT NO.					
(ER 415 1-10)																									
TITLE AND LOCATION										CONTRACTOR										SPECIFICATION SECTION					
WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA																				04200					
ACTIVITY NO a.	TRANSMITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL										CLASSIFICATION		CONTRACTOR SCHEDULE DATES			CONTRACTOR ACTION			GOVERNMENT ACTION		REMARKS aa.
					DRAWINGS f.	INSTALLATION g.	STRUCTURES h.	STAIRS i.	CERAMIC j.	TILES k.	PAINT l.	SMA m.	O&M n.	INFORM o.	GOVERNANCE p.	SUBMIT q.	APPROVAL NEEDED BY r.	MATERIAL NEEDED BY s.	DATE t.	SUBMIT TO GOVERNMENT u.	DATE v.				
																						C O D E y.	DATE z.		



CONTRACT NO.

## TITLE AND LOCATION

CONTRACTOR

SPECIFICATION SECTION

**WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA**

**05055**

[illegible]

CONTRACT NO.

CONTRACTOR

SPECIFICATION SECTION

**05120**

[illegible]

CONTRACT NO.
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CONTRACTOR

**SPECIFICATION SECTION**

**05210**

[illegible]

CONTRACT NO.

CONTRACTOR

SPECIFICATION SECTION

**05300**

[illegible]

CONTRACT NO.
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CONTRACTOR

SPECIFICATION SECTION

**WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA**

**05410**

[illegible]

CONTRACT NO.

CONTRACTOR

SPECIFICATION SECTION

05500

[illegible]

CONTRACT NO.
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CONTRACTOR

SPECIFICATION SECTION

**WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA**

06100

[illegible]

CONTRACT NO.
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CONTRACTOR

**SPECIFICATION SECTION**

**06200**

[illegible]



CONTRACT NO.

## TITLE AND LOCATION

CONTRACTOR

SPECIFICATION SECTION

**WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA**

**06410**

[illegible]

CONTRACT NO.
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CONTRACTOR

**SPECIFICATION SECTION**

**07111**

[illegible]

CONTRACT NO.
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CONTRACTOR

**SPECIFICATION SECTION**

**07112**

[illegible]

CONTRACT NO.
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CONTRACTOR

**SPECIFICATION SECTION**

**07240**

ACTIVITY NO. a.

CONTRACT NO.
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CONTRACTOR

**SPECIFICATION SECTION**

**07250**

[illegible]

CONTRACT NO.

## TITLE AND LOCATION

CONTRACTOR

SPECIFICATION SECTION

**WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA**

**07270**

[illegible]

SUBMITTAL REGISTER																					CONTRACT NO.				
(ER 415 1-10)																									
TITLE AND LOCATION											CONTRACTOR						SPECIFICATION SECTION								
WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA																	07412								
ACTIVITY NO a.	TRANS-MITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL										CLASSIFICATION		CONTRACTOR SCHEDULE DATES			CONTRACTOR ACTION			GOVERNMENT ACTION		REMARKS aa.
					DRAWINGS f.	INSTALLATION g.	STANDARD h.	STANDARD i.	STANDARD j.	STANDARD k.	STANDARD l.	STANDARD m.	STANDARD n.	STANDARD o.	STANDARD p.	STANDARD q.	STANDARD r.	SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	DATE v.	SUBMIT TO GOVERNMENT w.	DATE x.	GOVERNMENT ACTION y.	

CONTRACT NO.

CONTRACTOR

SPECIFICATION SECTION

**07413**

ACTIVITY NO.	TRANSMITTAL NO.	ITEM NO.	SPECIFICATION PARAGRAPH NUMBER	DESCRIPTION OF ITEM SUBMITTED	TYPE OF SUBMITTAL												CLASSIFICATION		CONTRACTOR SCHEDULE DATES			CONTRACTOR ACTION		GOVERNMENT ACTION		REMARKS
					DRAWINGS	INSTRUMENTS	STANDARD SPECIFICATIONS	CALCULATIONS	RECORDS	O&M	INFORMATION	GOVERNMENT	REVIEW	SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	DATE	SUBMIT TO GOVERNMENT	DATE							
																				f.	g.	h.	i.	j.	k.	
a.	b.	c.	d.	e.	f.	g.	h.	i.	j.	k.	l.	m.	n.	o.	p.	q.	r.	s.	t.	u.	v.	w.	x.	y.	z.	aa.
			1.3	Siding	X											X										
			1.3	Siding						X					X											
			1.3	Installation						X					X											
			1.3	Accessories						X					X											
			1.3	Insulation						X					X											
			1.3	Accessories							X				X											
			1.3	Siding						X					X											
			1.3	Fasteners						X					X											
			1.3	Insulation						X					X											
			1.3	Gaskets and Insulating Compounds						X					X											
			1.3	Sealant						X					X											
			1.3	Wall Liners						X					X											



CONTRACT NO.
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CONTRACTOR

**SPECIFICATION SECTION**

**07600**

[illegible]

CONTRACT NO.
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CONTRACTOR

**SPECIFICATION SECTION**

**07820**

[illegible]

CONTRACT NO.

CONTRACTOR

SPECIFICATION SECTION

**07900**

[illegible]

SUBMITTAL REGISTER																					CONTRACT NO.				
(ER 415 1-10)																									
TITLE AND LOCATION														CONTRACTOR						SPECIFICATION SECTION					
WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA																				08110					
ACTIVITY NO a.	TRANSMITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL										CLASSIFICATION		CONTRACTOR SCHEDULE DATES			CONTRACTOR ACTION			GOVERNMENT ACTION		REMARKS aa.
					DRAWINGS f.	INSTALLATION g.	STRUCTURES h.	STAIRS i.	CERAMIC j.	TILES k.	PAINT l.	ROOFING m.	MECHANICAL n.	ELECTRICAL o.	INFORMATION p.	GOVERNANCE q.	SUBMIT r.	APPROVAL NEEDED BY s.	MATERIAL NEEDED BY t.	DATE u.	SUBMIT TO GOVERNMENT v.	DATE w.	CODE x.	DATE y.	

CONTRACT NO.
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CONTRACTOR

**SPECIFICATION SECTION**

**08120**

# ACTIVITY

SUBMITTAL REGISTER																					CONTRACT NO.				
(ER 415 1-10)																									
TITLE AND LOCATION											CONTRACTOR						SPECIFICATION SECTION								
WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA																	08210								
ACTIVITY NO a.	TRANSMITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL										CLASSIFICATION		CONTRACTOR SCHEDULE DATES			CONTRACTOR ACTION			GOVERNMENT ACTION		REMARKS aa.
					DRAWINGS f.	INSTALLATION g.	STRUCTURES h.	STAIRS i.	SPECIALTIES j.	CERTIFICATES k.	SPECIALTIES l.	SPECIALTIES m.	SPECIALTIES n.	SPECIALTIES o.	SPECIALTIES p.	SPECIALTIES q.	SPECIALTIES r.	SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	DATE v.	SUBMIT TO GOVERNMENT w.	DATE x.	GOVERNMENT ACTION y.	

CONTRACT NO.

CONTRACTOR

SPECIFICATION SECTION

**08520**

[illegible]

(ER 415 1-10)

SPECIFICATION SECTION

GOVERNMENT  
ACTION

CONTRACTOR
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2

[illegible]



CONTRACT NO.
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CONTRACTOR

SPECIFICATION SECTION

**WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA**

**08810**

CONTRACT NO.
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CONTRACTOR

**SPECIFICATION SECTION**

**08920**

[illegible]

CONTRACT NO.
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CONTRACTOR

**SPECIFICATION SECTION**

**08952**

[illegible]

CONTRACT NO.

CONTRACTOR

SPECIFICATION SECTION

**08960**

[illegible]

CONTRACT NO.

CONTRACTOR

SPECIFICATION SECTION

**09250**

[illegible]

CONTRACT NO.
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CONTRACTOR

**SPECIFICATION SECTION**

**09310**

ACTIVITY NO.	TRANSMITTAL NO.	ITEM NO.	SPECIFICATION PARAGRAPH NUMBER	DESCRIPTION OF ITEM SUBMITTED	TYPE OF SUBMITTAL								CLASSIFICATION			CONTRACTOR SCHEDULE DATES			CONTRACTOR ACTION			GOVERNMENT ACTION		REMARKS
					DRAWINGS AND TEMPLATES	INSTRUCTIONS	STANDARD SPECIFICATIONS	CERTIFICATES	OTHER INFORMATION	O & M INSTRUCTIONS	GOVERNANCE DOCUMENTATION	APPROVAL DATE	SUBMIT TO GOVERNMENT	DATE		CODE	WARRANTY PERIOD	DATE	ZONING CODE					

CONTRACT NO.

CONTRACTOR

SPECIFICATION SECTION

**WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA**

**09510**

[illegible]

CONTRACT NO.

## TITLE AND LOCATION

CONTRACTOR

SPECIFICATION SECTION

**WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA**

09650

[illegible]



CONTRACT NO.
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CONTRACTOR

**SPECIFICATION SECTION**

**09680**

# ACTIVITY

CONTRACT NO.
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## CONTRACTOR

**SPECIFICATION SECTION**

**09840**

[illegible]

CONTRACT NO.

CONTRACTOR

SPECIFICATION SECTION

**09900**

[illegible]

CONTRACT NO.
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CONTRACTOR

SPECIFICATION SECTION

**WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA**

**09915**

[illegible]

SUBMITTAL REGISTER																				CONTRACT NO.					
(ER 415 1-10)																									
TITLE AND LOCATION										CONTRACTOR										SPECIFICATION SECTION					
WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA																				09950					
ACTIVITY NO a.	TRANSMITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL										CLASSIFICATION		CONTRACTOR SCHEDULE DATES			CONTRACTOR ACTION			GOVERNMENT ACTION		REMARKS aa.
					DRAWINGS f.	INSTALLATION g.	STANDARD h.	STANDARD i.	STANDARD j.	STANDARD k.	STANDARD l.	STANDARD m.	STANDARD n.	STANDARD o.	STANDARD p.	STANDARD q.	STANDARD r.	SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	DATE v.	SUBMIT TO GOVERNMENT w.	DATE x.	GOVERNMENT ACTION y.	

SUBMITTAL REGISTER																				CONTRACT NO.					
(ER 415 1-10)																									
TITLE AND LOCATION										CONTRACTOR										SPECIFICATION SECTION					
WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA																				09986					
ACTIVITY NO a.	TRANSMITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL										CLASSIFICATION		CONTRACTOR SCHEDULE DATES			CONTRACTOR ACTION			GOVERNMENT ACTION		REMARKS aa.
					DRAWINGS f.	INSTALLATION g.	STANDARD h.	STANDARD i.	STANDARD j.	STANDARD k.	STANDARD l.	STANDARD m.	STANDARD n.	STANDARD o.	STANDARD p.	STANDARD q.	STANDARD r.	SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	DATE v.	SUBMIT TO GOVERNMENT w.	DATE x.	GOVERNMENT ACTION y.	

CONTRACT NO.
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## CONTRACTOR

**SPECIFICATION SECTION**

**10160**

ACTIVITY NO. a.

CONTRACT NO.

## TITLE AND LOCATION

CONTRACTOR

SPECIFICATION SECTION

**WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA**

10440

[illegible]



CONTRACT NO.

CONTRACTOR

SPECIFICATION SECTION

**10501**

[illegible]

CONTRACT NO.
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CONTRACTOR

**SPECIFICATION SECTION**

**10550**

[illegible]

CONTRACT NO.
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CONTRACTOR

SPECIFICATION SECTION

**WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA**

**10800**

[illegible]

SUBMITTAL REGISTER																							CONTRACT NO.		
(ER 415 1-10)																									
TITLE AND LOCATION														CONTRACTOR							SPECIFICATION SECTION				
WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA																					11211				
ACTIVITY NO a.	TRANSMITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL										CLASSIFICATION		CONTRACTOR SCHEDULE DATES			CONTRACTOR ACTION			GOVERNMENT ACTION		REMARKS aa.
					DRAWINGS f.	INSTALLATION g.	STANDARD h.	STANDARD i.	STANDARD j.	STANDARD k.	STANDARD l.	STANDARD m.	STANDARD n.	STANDARD o.	STANDARD p.	STANDARD q.	STANDARD r.	SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	DATE v.	SUBMIT TO GOVERNMENT w.	DATE x.	GOVERNMENT ACTION y.	

SUBMITTAL REGISTER																				CONTRACT NO.					
(ER 415 1-10)																									
TITLE AND LOCATION										CONTRACTOR										SPECIFICATION SECTION					
WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA																				11450					
ACTIVITY NO a.	TRANSMITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL										CLASSIFICATION		CONTRACTOR SCHEDULE DATES			CONTRACTOR ACTION			GOVERNMENT ACTION		REMARKS aa.
					DRAWINGS f.	INSTRUMENTS g.	STANDARD h.	STANDARD i.	STANDARD j.	STANDARD k.	STANDARD l.	STANDARD m.	STANDARD n.	STANDARD o.	STANDARD p.	STANDARD q.	STANDARD r.	SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	DATE v.	SUBMIT TO GOVERNMENT w.	DATE x.	GOVERNMENT ACTION y.	

CONTRACT NO.
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CONTRACTOR

**SPECIFICATION SECTION**

**12490**

[illegible]

CONTRACT NO.
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CONTRACTOR

**SPECIFICATION SECTION**

**12690**

[illegible]

CONTRACT NO.

CONTRACTOR

SPECIFICATION SECTION

**WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA**

13080

[illegible]



CONTRACT NO.

## TITLE AND LOCATION

CONTRACTOR

SPECIFICATION SECTION

**WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA**

**13100**

WHOLE DATA FOR COMPLEXITY: STEEL, OKLAHOMA																																																																																																																																																																																																																																																																																																																																																																																																																																																								
ACTIVITY NO.	TRANSMITTAL NO.	ITEM NO.	SPECIFICATION PARAGRAPH NUMBER	DESCRIPTION OF ITEM SUBMITTED	TYPE OF SUBMITTAL										CLASSIFICATION		CONTRACTOR SCHEDULE DATES			CONTRACTOR ACTION		GOVERNMENT ACTION		REMARKS																																																																																																																																																																																																																																																																																																																																																																																																																																
					DRAWING	INSTRUMENT	STRUCTURAL	CALCULATIONS	TRIAL	CAM	P	O	R	M	I	N	F	O	R	M	A	P	R		V	I	E	W	E	R	S	U	B	M	I	T	O	G	O	V	A	R	E	P	V	I	E	W	E	R	S	U	B	M	I	T	O	G	O	V	A	R	E	P	V	I	E	W	E	R	S	U	B	M	I	T	O	G	O	V	A	R	E	P	V	I	E	W	E	R	S	U	B	M	I	T	O	G	O	V	A	R	E	P	V	I	E	W	E	R	S	U	B	M	I	T	O	G	O	V	A	R	E	P	V	I	E	W	E	R	S	U	B	M	I	T	O	G	O	V	A	R	E	P	V	I	E	W	E	R	S	U	B	M	I	T	O	G	O	V	A	R	E	P	V	I	E	W	E	R	S	U	B	M	I	T	O	G	O	V	A	R	E	P	V	I	E	W	E	R	S	U	B	M	I	T	O	G	O	V	A	R	E	P	V	I	E	W	E	R	S	U	B	M	I	T	O	G	O	V	A	R	E	P	V	I	E	W	E	R	S	U	B	M	I	T	O	G	O	V	A	R	E	P	V	I	E	W	E	R	S	U	B	M	I	T	O	G	O	V	A	R	E	P	V	I	E	W	E	R	S	U	B	M	I	T	O	G	O	V	A	R	E	P	V	I	E	W	E	R	S	U	B	M	I	T	O	G	O	V	A	R	E	P	V	I	E	W	E	R	S	U	B	M	I	T	O	G	O	V	A	R	E	P	V	I	E	W	E	R	S	U	B	M	I	T	O	G	O	V	A	R	E	P	V	I	E	W	E	R	S	U	B	M	I	T	O	G	O	V	A	R	E	P	V	I	E	W	E	R	S	U	B	M	I	T	O	G	O	V	A	R	E	P	V	I	E	W	E	R	S	U	B	M	I	T	O	G	O	V	A	R	E	P	V	I	E	W	E	R	S	U	B	M	I	T	O	G	O	V	A	R	E	P	V	I	E	W	E	R	S	U	B	M	I	T	O	G	O	V

CONTRACT NO.

**CONTRACTOR**

**SPECIFICATION SECTION**

**WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA**

**13121**

[illegible]

CONTRACT NO.

CONTRACTOR

SPECIFICATION SECTION

13814

[illegible]



CONTRACT NO.

CONTRACTOR

SPECIFICATION SECTION

**WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA**

**15330**

[illegible]

CONTRACT NO.

CONTRACTOR

SPECIFICATION SECTION

**15331**

[illegible]

(ER 415 1-10)

SPECIFICATION SECTION

GOVERNMENT  
ACTION

CONTRACTOR
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ACTIVITY NO.	TRANSMITTAL NO.	ITEM NO.	SPECIFICATION PARAGRAPH NUMBER	DESCRIPTION OF ITEM SUBMITTED	TYPE OF SUBMITTAL								CLASSIFICATION		REVIEWER	CONTRACTOR SCHEDULE DATES			CONTRACTOR ACTION			GOVERNMENT ACTION		REMARKS
					DRAWINGS	INSTRUMENTATION	STANDARD REPORTS	CERTIFICATES	SAMPLING	RECORDS	O&M	INFORMATION ONLY	GOVERNMENT REVIEWED			SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	CODE	DATE	SUBMIT TO GOVERNMENT	CODE	DATE	

SUBMITTAL REGISTER																					CONTRACT NO.				
(ER 415 1-10)																									
TITLE AND LOCATION													CONTRACTOR						SPECIFICATION SECTION						
WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA																			15488						
ACTIVITY NO a.	TRANSMITTAL NO. b.	ITEM NO c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL										CLASSIFICATION		CONTRACTOR SCHEDULE DATES			CONTRACTOR ACTION			GOVERNMENT ACTION		REMARKS
					DRAWINGS f.	INSTALLATION g.	STANDARD h.	STANDARD i.	STANDARD j.	STANDARD k.	STANDARD l.	STANDARD m.	STANDARD n.	STANDARD o.	STANDARD p.	STANDARD q.	STANDARD r.	SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	DATE v.	SUBMIT TO GOVERNMENT w.	DATE x.	GOVERNMENT ACTION y.	



CONTRACT NO.

CONTRACTOR

SPECIFICATION SECTION

**15556**

[illegible]

CONTRACT NO.

(ER 415 1-10)

### TITLE AND LOCATION

**CONTRACTOR**

**SPECIFICATION SECTION**

## WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA

**15569**

[illegible]

CONTRACT NO.

**CONTRACTOR**

**SPECIFICATION SECTION**

## WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA

**15650**

ACTIVITY NO.	TRANSMITTAL NO.	ITEM NO.	SPECIFICATION PARAGRAPH NUMBER	DESCRIPTION OF ITEM SUBMITTED	TYPE OF SUBMITTAL								CLASSIFICATION			CONTRACTOR SCHEDULE DATES			CONTRACTOR ACTION			GOVERNMENT ACTION		REMARKS
					DRAWINGS	INSTRUCTIONS	STANDARD	CERTIFICATE	FORM	& MATERIAL	INFORMATION	GOVERNANCE	APPROVAL NEEDED BY	MATERIAL NEEDED BY		DATE	SUBMIT TO GOVERNMENT	CODE	DATE	REMARKS				

CONTRACT NO.

(ER 415 1-10)

## TITLE AND LOCATION

CONTRACTOR

SPECIFICATION SECTION

**WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA**

**15895**

[illegible]

CONTRACT NO.

CONTRACTOR

SPECIFICATION SECTION

15950

[illegible]

CONTRACT NO.
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**SPECIFICATION SECTION**

**15990**

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CONTRACTOR

**SPECIFICATION SECTION**

**15995**

[illegible]

CONTRACT NO.

## CONTRACTOR

**SPECIFICATION SECTION**

**16370**

[illegible]



CONTRACT NO.

**CONTRACTOR**

SPECIFICATION SECTION

**WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA**

16375

CONTRACT NO.
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CONTRACTOR

**SPECIFICATION SECTION**

**16415**

[illegible]

CONTRACT NO.

## TITLE AND LOCATION

CONTRACTOR

SPECIFICATION SECTION

**WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA**

16528

[illegible]

CONTRACT NO.
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CONTRACTOR

**SPECIFICATION SECTION**

**16642**

[illegible]

CONTRACT NO.

CONTRACTOR

SPECIFICATION SECTION

**WHOLE BARRACKS COMPLEX, FT. SILL, OKLAHOMA**

**16721**

[illegible]

## SECTION 01310

## PROJECT SCHEDULE

## 1 GENERAL

## 1.1 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300.

## SD-07 Schedules

Initial Project Schedule; GA. Preliminary Project Schedule; GA. Periodic Schedule Updates; GA.

Three copies of the schedules showing codes, values, categories, numbers, items, etc., as required.

## SD-08 Statements

Qualifications; GA.

Documentation showing qualifications of personnel preparing schedule reports.

## SD-09 Reports

Narrative Report; GA. Schedule Reports; GA.

Three copies of the reports showing numbers, descriptions, dates, float, starts, finishes, durations, sequences, etc., as required.

## 1.2 QUALIFICATIONS

The Contractor shall designate an authorized representative who shall be responsible for the preparation of all required project schedule reports. This person shall have previously created and reviewed computerized schedules. Qualifications of this individual shall be submitted to the Contracting Officer for review with the Preliminary Project Schedule submission.

## 2 PRODUCTS (NOT APPLICABLE)

## 3 EXECUTION

## 3.1 GENERAL

Pursuant to the Contract Clause, SCHEDULE FOR CONSTRUCTION CONTRACTS a Project Schedule as described below shall be prepared. The scheduling of construction shall be the responsibility of the Contractor. Contractor management personnel shall actively participate in its development. Subcontractors and suppliers working on the project should also contribute in developing and maintaining an accurate Project Schedule. The approved Project Schedule shall be used to measure the progress of the work, to aid

in evaluating time extensions, and to provide the basis of all progress payments.

### 3.2 BASIS FOR PAYMENT

The schedule shall be the basis for measuring Contractor progress. Lack of an approved schedule or scheduling personnel shall result in an inability of the Contracting Officer to evaluate Contractor progress for the purposes of payment. Failure of the Contractor to provide all information, as specified below, shall result in the disapproval of the entire Project Schedule submission and the inability of the Contracting Officer to evaluate Contractor progress for payment purposes. In the case where Project Schedule revisions have been directed by the Contracting Officer and those revisions have not been included in the Project Schedule, then the Contracting Officer may hold retainage up to the maximum allowed by contract, each payment period, until revisions to the Project Schedule have been made.

### 3.3 PROJECT SCHEDULE

The computer software system utilized by the Contractor to produce the Project Schedule shall be capable of providing all requirements of this specification. Failure of the Contractor to meet the requirements of this specification shall result in the disapproval of the schedule. Manual methods used to produce any required information shall require approval by the Contracting Officer.

#### 3.3.1 Use of the Critical Path Method

The Critical Path Method (CPM) of network calculation shall be used to generate the Project Schedule. The Contractor shall provide the Project Schedule in either the Precedence Diagram Method (PDM) or the Arrow Diagram Method (ADM).

#### 3.3.2 Level of Detail Required

With the exception of the initial and preliminary schedule submission, the Project Schedule shall include an appropriate level of detail. Failure to develop or update the Project Schedule or provide data to the Contracting Officer at the appropriate level of detail, as specified by the Contracting Officer, shall result in the disapproval of the schedule. The Contracting Officer will use, but is not limited to, the following conditions to determine the appropriate level of detail to be used in the Project Schedule.

##### 3.3.2.1 Activity Durations

Contractor submissions shall be required to follow the direction of the Contracting Officer regarding reasonable activity durations. Reasonable durations are those that allow the progress of activities to be accurately determined between payment periods. A rule of thumb, that the Contractor should use, is that less than 2 percent of all non-procurement activities' Original Durations shall be greater than 20 days.

### 3.3.2.2 Procurement Activities

Tasks related to the procurement of long lead materials or equipment shall be included as separate activities in the project schedule. Long lead materials and equipment are those materials that have a procurement cycle of over 90 days. Examples of procurement process activities include, but are not limited to: submittals, approvals, procurement, fabrication, delivery, installation, start-up, and testing.

### 3.3.2.3 Government Activities

Government and other agencies activities that could impact progress shall be shown. These activities include, but are not limited to: approvals, inspections, utility tie-in, Government Furnished Equipment (GFE) and notice to proceed for phasing requirements.

### 3.3.2.4 Workers Per Day

All activities shall have an estimate of the average number of workers per day that are expected to be used during the execution of the activity. If no workers are required for an activity, in the case of activities related to procurement, for example, then the activity shall be identified as using zero workers per day. The workers per day information for each activity shall be identified by the Workers Per Day Code.

### 3.3.2.5 Responsibility

All activities shall be identified in the project schedule by the party responsible to perform the work. Responsibility includes, but is not limited to, the subcontracting firm, contractor work force, or government agency performing a given task. Activities shall not belong to more than one responsible party. The responsible party for each activity shall be identified by the Responsibility Code.

### 3.3.2.6 Work Areas

All activities shall be identified in the project schedule by the work area in which the activity occurs. Activities shall not be allowed to cover more than one work area. The work area of each activity shall be identified by the Work Area Code.

### 3.3.2.7 Modification or Claim Number

Any activity that is added or changed by contract modification or used to justify claimed time shall be identified by a mod or claim code that changed the activity. Activities shall not belong to more than one modification or claim item. The modification or claim number of each activity shall be identified by the Mod or Claim Number.

### 3.3.2.8 Bid Item

All activities shall be identified in the project schedule by the Bid Item to which the activity belongs. An activity shall not contain work in more than one bid item. the bid item for each appropriate activity shall be identified by the Bid Item Code.



### 3.3.2.9 Phase of Work

All activities shall be identified in the project schedule by the phases of work in which the activity occurs. Activities shall not be allowed to contain work in more than one phase of work. The project phase of each activity shall be by the unique Phase of Work Code.

### 3.3.2.10 Category of Work

All Activities shall be identified in the project schedule according to the category of work which best describes the activity. Category of work refers, but is not limited to, to the procurement chain of activities including such items as submittals, approvals, procurement, fabrication, delivery, installation, start-up, and testing. The category of work for each activity shall be identified by the Category of Work Code.

### 3.3.2.11 Feature of Work

All activities shall be identified in the project schedule according to the feature of work to which the activity belongs. Feature of work refers, but is not limited to a work breakdown structure for the project. The feature of work for each activity shall be identified by the Feature of Work Code.

## 3.3.3 Scheduled Project Completion

The schedule interval shall extend from notice-to-proceed to the contract completion date.

### 3.3.3.1 Project Start Date

The schedule shall start no earlier than the date that the Notice to Proceed (NTP) was acknowledged. The Contractor shall include as the first activity in the project schedule an activity called "Start Project". The "Start Project" activity shall have: a "ES" constraint, a constraint date equal to the date that the NTP was acknowledged, and a zero day duration.

### 3.3.3.2 Constraint of Last Activity

Completion of the last activity in the schedule shall be constrained by the contract completion date. Calculation on project updates shall be such that if the early finish of the last activity falls after the contract completion date, then the float calculation shall reflect a negative float on the critical path. The Contractor shall include as the last activity in the project schedule an activity call "End Project". The "End Project" activity shall have: a "LF" constraint, a constraint date equal to the completion date for the project, and a zero day duration.

### 3.3.3.3 Early Project Completion

In the event the project schedule shows completion, the project prior to the contract completion date, the Contractor shall identify those activities that have been accelerated and/or those activities that are scheduled in parallel to support the Contractor's "early" completion. Contractor shall specifically address each of the activities noted at every project schedule update period to assist the Contracting Officer to evaluate the Contractor's ability to actually complete prior to the contract period.

#### 3.3.4 Interim Completion Dates

Contractually specified interim completion dates shall also be constrained to show negative float if the early finish date of the last activity in that phase falls after the interim completion date.

##### 3.3.4.1 Start Phase

The Contractor shall include as the first activity for a project phase an activity called "Start Phase X" where "X" refers to the phase of work. The "Start Phase X" activity shall have: a "ES" constraint, a constraint date equal to the date that the NTP was acknowledged, and a zero day duration.

##### 3.3.4.2 End Phase

The Contractor shall include as the last activity in a project phase an activity called "End Phase X" where "X" refers to the phase of work. The "End Phase X" activity shall have: a "LF" constraint, a constraint date equal to the completion date for the project, and a zero day duration.

##### 3.3.4.3 Phase X

The Contractor shall include a hammock type activity for each project phase called "Phase X" where "X:" refers to the phase of work. The "Phase X" activity shall be logically tied to the earliest and latest activities in the phase.

#### 3.3.5 Default Progress Data Disallowed

Actual Start and Finish dates shall not be automatically updated by default mechanisms that may be included in CPM scheduling software systems. Actual Start and Finish dates on the CPM schedule shall match those dates provided from Contractor Quality Control Reports. Failure of the Contractor to document the Actual Start and Finish dates on the Daily Quality Control report for every in progress or completed activity and insure that the data contained on the Daily Quality Control reports is the sole basis for schedule updating shall result in the disapproval of the Contractor's schedule and the inability of the Contracting Officer to evaluate Contractor progress for payment purposes.

#### 3.3.6 Out-of-Sequence Progress

Activities that have posted progress without predecessors being completed (Out-of-Sequence Progress) shall be allowed only by the case-by-case approval of the Contracting Officer. The Contracting Officer may direct that changes in schedule logic be made to correct any or all out-of-sequence work.

#### 3.3.7 Extended Non-Work Periods

Designation of Holidays to account for non-work periods of over 5 days shall not be allowed. Non-work periods of over 5 days shall be identified by addition of activities that represent the delays. Modifications to the logic of the project schedule shall be made to link those activities that may have been impacted by the delays to the newly added delay activities.

### 3.3.8 Negative Lags

Lag durations contained in the project schedule shall not have a negative value.

## 3.4 PROJECT SCHEDULE SUBMISSIONS

The Contractor shall provide the submissions as described below. The data disk, reports, and network diagrams required for each submission are contained in paragraph SUBMISSION REQUIREMENTS.

### 3.4.1 Preliminary Project Schedule Submission

The Preliminary Project Schedule, defining the Contractor's planned operations for the first 60 calendar days shall be submitted for approval within 20 calendar days after Notice to Proceed is acknowledged. The approved preliminary schedule shall be used for payment purposes not to exceed 60 calendar days after Notice to Proceed.

### 3.4.2 Initial Project Schedule Submission

The Initial Project Schedule shall be submitted for approval within 40 calendar days after Notice to Proceed. The schedule shall provide a reasonable sequence of activities which represent work through the entire project and shall be at a reasonable level of detail.

### 3.4.3 Periodic Schedule Updates

Based on the result of progress meetings, specified in "Periodic Progress Meetings," the Contractor shall submit periodic schedule updates. These submissions shall enable the Contracting Officer or to assess Contractor's progress. If the Contractor fails or refuses to furnish the information and project schedule data, which in the judgement of the Contracting Officer or authorized representative, is necessary for verifying the contractor's progress, the Contractor shall be deemed not to have provided an estimate upon which progress payment may be made.

### 3.4.4 Standard Activity Coding Dictionary

The Contractor shall submit, with the Initial Project Schedule, a coding scheme that shall be used throughout the project for all activity codes contained in the schedule. The coding scheme submitted shall list the values for each activity code category and translate those values into project specific designations. For example, a Responsibility Code Value, "ELE", may be identified as "Electrical Subcontractor." Activity code values shall represent the same information throughout the duration of the contract. Once approved with the Initial Project Schedule submission, changes to the activity coding scheme must be approved by the Contracting Officer.

## 3.5 SUBMISSION REQUIREMENTS

The following items shall be submitted by the Contractor for the initial submission, and every periodic project schedule update throughout the life of the project:

### 3.5.1 Data Disks

Three data disks containing the project schedule shall be provided. Data on the disks shall be in the format specified in APPENDIX A.

#### 3.5.1.1 File Medium

Required data shall be submitted on 3.5 disks, formatted to hold 1.44 MB of data, under the MS-DOS operating system.

#### 3.5.1.2 Disk Label

A permanent exterior label shall be affixed to each disk submitted. The label shall indicate the type of schedule (Initial, Update, or Change), full contract number, project name, project location, data date, name and telephone number or person responsible for the schedule, and the MS-DOS version used to format the disk.

#### 3.5.1.3 File Name

Each file submitted shall have a name related to either the schedule data date, project name, or contract number. The Contractor shall develop a naming convention that will insure that the names of the files submitted are unique. The Contractor shall submit the file naming convention to the Contracting Officer for approval.

### 3.5.2 Narrative Report

A Narrative Report shall be provided with each update of the project schedule. This report shall be provided as the basis of the Contractor's progress payment request. The Narrative Report shall include: a description of activities along the 4 most critical paths, a description of current and anticipated problem areas or delaying factors and their impact, and an explanation of corrective actions taken.

### 3.5.3 Approved Changes Verification

Only project schedule changes that have been previously approved by the Contracting Officer shall be included in the schedule submission. The Narrative Report shall specifically reference, on an activity by activity basis, all changes made since the previous period and relate each change to documented, approved schedule changes.

### 3.5.4 Schedule Reports

The format for each activity for the schedule reports listed below shall contain: Activity Numbers, Activity Description, Original Duration, Remaining Duration, Early Start Date, Early Finish Date, Late Start Date, Late Finish Date, Total Float. Actual Start and Actual Finish Dates shall be printed for those activities in-progress or completed.

#### 3.5.4.1 Activity Report

A list of all activities sorted according to activity number or "I-NODE" AND "J-NODE" and then sorted according to Early Start Date. For completed activities the Actual Start Date shall be used as the secondary sort.

#### 3.5.4.2 Logic Report

A list of Preceding and Succeeding activities for every activity in ascending order by activity number and then sorted according to Early Start Date. For completed activities the Actual Start Date shall be used as the secondary sort.

#### 3.5.4.3 Total Float Report

A list of all activities sorted in ascending order of total float. Activities which have the same amount of total float shall be listed in ascending order of Early Start Dates.

#### 3.5.4.4 Earnings Report

A compilation of the Contractor's Total Earnings on the project from the Notice to Proceed until the most recent Monthly Progress Meeting. This report shall reflect the Earnings of specific activities based on the agreements made in the field and approved between the Contractor and Contracting Officer at the most recent Monthly Progress Meeting. Provided that the Contractor has provided a complete schedule update, this report shall serve as the basis of determining Contractor Payment. Activities shall be grouped by bid item and sorted by activity numbers. This report shall: sum all activities in a bid item and provide a bid item percent; complete and sum all bid items to provide a total project percent complete. The printed report shall contain, for each activity: Activity Number or "i-node" and "j-node", Activity Description, Original Budgeted Amount, Total Quantity, Quantity to Date, Percent Complete (based on cost), Earnings to Date.

#### 3.5.5 Network Diagram

The network diagram shall be required on the initial schedule submission and on monthly or quarterly schedule update submissions. The network diagram shall depict and display the order and interdependence of activities and the sequence in which the work is to be accomplished. The Contracting Officer will use, but is not limited to, the following conditions to review compliance with this paragraph:

##### 3.5.5.1 Continuous Flow

Diagrams shall show a continuous flow from left to right with no arrows from right to left. The activity or event number, description, duration, and estimated earned value shall be shown on the diagram.

##### 3.5.5.2 Project Milestone Dates

Dates shall be shown on the diagram for start of project, any contract required interim completion dates, and contract completion dates.

##### 3.5.5.3 Critical Path

The critical path shall be clearly shown.

#### 3.5.5.4 Banding

Activities shall be grouped to assist in the understanding of the activity sequence. Typically, this flow will group activities by category of work, work area and/or responsibility.

#### 3.5.5.5 S-Curves

Earnings curves showing projected early and late earnings and earnings to date.

### 3.6 PERIODIC PROGRESS MEETINGS

Progress meetings to discuss payment shall include a monthly on-site meeting or other regular intervals mutually agreed to at the preconstruction conference. During this meeting the Contractor will describe, on an activity by activity basis, all proposed revisions and adjustments to the project schedule required to reflect the current status of the project. The Contracting Officer will approve activity progress, proposed revisions, and adjustments as appropriate.

#### 3.6.1 Meeting Attendance

The Contractor's Project Manager and Scheduler shall attend the regular progress meeting.

#### 3.6.2 Update Submission Following Progress Meeting

A complete update of the project schedule containing all approved progress, revisions, and adjustments, based on the regular progress meeting, shall be submitted not later than 4 working days after the monthly progress meeting.

#### 3.6.3 Progress Meeting Contents

Update information, including Actual Start Dates, Actual Finish Dates, Remaining Durations, and Cost to Date shall be subject to the approval of the Contracting Officer. The following minimum set of items which the Contractor shall address, on an activity by activity basis, during each progress meeting.

##### 3.6.3.1 Start and Finish Dates

The Actual Start and Actual Finish dates for each activity currently in-progress or completed activities.

##### 3.6.3.2 Time Completion

The estimated Remaining Duration for each activity in-progress. Time-based progress calculations must be based on Remaining Duration for each activity.

##### 3.6.3.3 Cost Completion

The earnings for each activity started. Payment shall be based on earnings for each in-progress or completed activity. Payment for individual activities shall not be made for work that contains quality defects. A portion of the overall project amount may be retained based on delays of activities.

#### 3.6.3.4 Logic Changes

All logic changes pertaining to Notice to Proceed on change orders, change orders to be incorporated into the schedule, contractor proposed changes in work sequence, corrections to schedule logic for out-of-sequence progress, lag durations, and other changes that have been made pursuant to contract provisions shall be specifically identified and discussed.

#### 3.6.3.5 Other Changes

Other changes required due to delays in completion of any activity or group of activities are those delays beyond the Contractors control such as strikes and unusual weather. Also included are delays encountered due to submittals, Government Activities, deliveries or work stoppage which makes re-planning the work necessary, and when the schedule does not represent the actual prosecution and progress of the work.

### 3.7 REQUESTS FOR TIME EXTENSIONS

In the event the Contractor requests an extension of the contract completion date, he shall furnish such justification, project schedule data and supporting evidence as the Contracting Officer may deem necessary for a determination as to whether or not the Contractor is entitled to an extension of time under the provisions of the contract. Submission of proof of delay, based on revised activity logic, duration, and costs (updated to the specific date that the delay occurred) is obligatory to any approvals.

#### 3.7.1 Justification of Delay

The project schedule must clearly display that the Contractor has used, in full, all the float time available for the work involved with this request. The Contracting Officer's determination as to the number of allowable days of contract extension, shall be based upon the project schedule updates in effect for the time period in question and other factual information. Actual delays that are found to be caused by the Contractor's own actions, which result in the extension of the schedule, shall not be a cause for a time extension to the contract completion date.

#### 3.7.2 Submission Requirements

The Contractor shall submit a justification for each request for a change in the contract completion date of under two weeks based upon the most recent schedule update at the time of the Notice to Proceed or constructive direction issued for the change. Such a request shall be in accordance with the requirements of other appropriate Contract Clauses and shall include, as a minimum:

- a. A list of affected activities, with their associated project schedule activity number.
- b. A brief explanation of the causes of the change.
- c. An analysis of the overall impact of the changes proposed.
- d. A sub-network of the affected area.

Activities impacted in each justification for change shall be identified by a unique activity code contained in the required data file.

### 3.7.3 Additional Submission Requirements

For any request for time extension for over 2 weeks, the Contracting Officer may request an interim update with revised activities for a specific change request. The Contractor shall provide this disk within 4 days of the Contracting Officer's request.

### 3.8 DIRECTED CHANGES

If Notice to Proceed (NTP) is issued for changes prior to settlement of price and/or time, the Contractor shall submit proposed schedule revisions to the Contracting Officer within 2 weeks of the NTP being issued. The proposed revisions to the schedule will be approved by the Contracting Officer prior to inclusion of those changes within the project schedule. If the Contractor fails to submit the proposed revisions, the Contracting Officer may furnish the Contractor suggested revisions to the project schedule. The Contractor shall include these revisions in the project schedule until the Contractor submits revisions, and final changes and impacts have been negotiated. If the Contractor has any objections to the revisions furnished by the Contracting Officer, then the Contractor shall advise the Contracting Officer within 2 weeks of receipt of the revisions. Regardless of the objections, the Contractor will continue to update their schedule with the Contracting Officer's revisions until a mutual agreement in the revisions may be made. If the Contractor fails to submit alternative revisions within 2 weeks of receipt of the Contracting Officer's proposed revisions, the Contractor will be deemed to have concurred with the Contracting Officer's proposed revisions. The proposed revisions will then be the basis for an equitable adjustment for performance of the work.

### 3.9 OWNERSHIP OF FLOAT

Float available in the schedule, at any time, shall not be considered for the exclusive use of either the Government or the Contractor.



## APPENDIX A

## DATA EXCHANGE FORMAT FOR CONTRACTOR PREPARED NAS

## 1. Description

The data exchange format provides a platform for exchanging scheduling and planning data between various software systems. The Data Exchange Format shall allow project management systems to share information with other programs. Scheduling information shall be transferred from the Contractor's project management system to the Government as described in this section.

## 2. Electronic Data Exchange

a. The Contractor shall provide schedule data in the Data Exchange Format for each Preliminary, Initial, Monthly NAS Updates, and requests for time extensions or change proposals. The Contractor's failure to provide schedule data in the format described herein shall result in disapproval of the entire schedule submission.

b. The entire set of schedule data shall be transferred at every exchange of scheduling data. Thus, for updates to existing projects, the data exchange file shall contain all activities that have not started or are already complete as well as those activities in progress.

## 3. Data Transfer Responsibility

The Contractor shall be responsible for Electronic Data exchange File data that may have been lost or destroyed during transit between the Contractor and the Contracting Officer. If Electronic Data Exchange File data is damaged during transit, then the Contractor shall provide the Contracting Officer with a new Electronic Data Exchange File within two working days of notification by the Contracting Officer.

## 4. Data Consistency Responsibility

The Contractor shall be responsible for the consistency between the Electronic Data Exchange File and printed reports which accompany schedule submissions. If Electronic Data Exchange File data for a schedule submission differs, in any way, from the printed schedule reports or standard activity coding, the Contracting Officer will disapprove the entire schedule submission. The Contractor shall provide the Contracting Officer with a completely revised and consistent schedule submission within 24 hours of notification of inconsistency by the Contracting Officer.

Creating the Electronic Data Exchange File: The Contractor may create the electronic data exchange file by one of the three following methods:

a. Commercially Available Software: Many commercially available scheduling systems support the standard data exchange format specified herein.

b. Interface Program: The Contractor shall produce his own data translation software. This software shall take the information

provided by the Contractor's scheduling system and reformat the data into the Data exchange Format.

c. Manual Methods: The Contractor shall manually reformat his scheduling system report files or create all necessary data by manually entering all data into the Data exchange Format.

#### 5. File Transfer Medium

All required data shall be submitted on 5 1/4" diskette(s), formatted to hold 360 KB of data, under the MS-DOS version 3.0 (or higher) operating system. Higher data densities and other operating systems may be approved by the Contracting Officer if compatible with the Government's computing capability,

#### 6. File Type and Format

The data file shall consist of a 132 character, fixed format, "ASCII" file. Text shall be left-justified and numbers shall be right-justified in each field. Data records must conform, exactly, to the sequence, column position, maximum length, mandatory values, and field definitions described below to comply with this standard data exchange format. Unless specifically stated, all numbers shall be whole numbers. All data columns shall be separated by a single blank column.

#### 7. Electronic Data Exchange File Name

The Contractor shall insure that each file has a name related to either the schedule data date, project name, or contract number. No two Electronic Data Exchange Files shall have the same name throughout the life of this contract. The Contractor shall submit his file naming convention to the Contracting Officer for approval. In the event that the Contractor's naming convention is disapproved, the Contracting Officer shall direct the Contractor to provide files under a unique file naming convention.

#### 8. Disc Label

The Contractor shall affix a permanent exterior label to each diskette submitted. The label shall contain the type of schedule (Preliminary, Initial, Update, or Change), full project number, project name, project location, data date, name and telephone number of the Contractor's scheduler, and the MS-DOS version used to format the diskette.

#### 9. Standard Activity Coding Dictionary

The Contractor shall submit, with the initial schedule submission, a consistent coding scheme that shall be used throughout the project for the Activity Codes specified in this section. The coding scheme submitted shall demonstrate that each code shall only represent one type of information through the duration of the contract. Incomplete coding of activities or an incomplete coding schedule shall be sufficient for disapproval of the schedule.

#### 10. Data Exchange File Format Organization

The Data Exchange File Format shall consist of the following records provided in the exact sequence shown below:

Record Description	Remarks
Volume Record	First Record on Every Data Disk
Project ID Record	Second Record
Calendar Record(s)	Minimum of One Record Required
Holiday Record(s)	Optional Record
Activity Record(s)	Mandatory Record
Precedence Records	Mandatory for Precedence Method
Unit Cost Record(s)	Optional for Unit Cost Projects
Progress Record(s)	Mandatory for Updates
File End Record	Last Record of Data File

#### 11. Record Descriptions

a. Volume Record: The Volume Record shall be used to control the transfer of data that may not fit on a single disk. The first record in every disk used to store the data exchange file shall contain the Volume Record. The Volume Record shall sequentially identify the number of the data transfer disk(s). The Volume Record shall have the following format:

Description	Column Position	Max. len.	Reqd. Value	Type	Just.
RECORD IDENTIFIER	1- 4	4	VOLM	Fixed	
DISK NUMBER	6- 7	2		Number	Right

(1) The RECORD IDENTIFIER is the first four characters of this record. The required value for this field shall be "VOLM".

(2) The DISK NUMBER field shall identify the number of the data disk used to store the data exchange information. If all data may be contained on a single disk, this field shall contain the value of "1". If more disks are required, then the second disk shall contain the value "2", the third disk shall be designated with a "3", and so on. Identification of the last data disk shall not be accomplished with the Volume Record. Identification of the last data disk is accomplished in the PROJECT END RECORD.

b. Project ID Record: The Project ID Record is the second record of the file and shall contain project information in the following format:

Description	Column Position	Max. Len.	Reqd. Value	Type	Just.
RECORD IDENTIFIER	1- 4	4	PROJ	Fixed	
DATA DATE	6- 12	7		ddmmyy	See (2)
PROJECT IDENTIFIER	14- 17	4		Alpha.	Left
PROJECT NAME	19- 66	48		Alpha.	Left
CONTRACTOR NAME	68-103	36		Alpha.	Left
ARROW OR PRECEDENCE	105	1	A,P	Fixed	
CONTRACT NUMBER	107-112	6		Alpha.	Left
PROJECT START	114-120	7		ddmmyy	Filled

PROJECT END                      122-128                      7                      ddmmyy      Filled

(1) The RECORD IDENTIFIER is the first four characters of this record. The required value for this field shall be "PROJ". This record shall contain the general project information and indicates which scheduling method shall be used.

(2) The DATA DATE is the date of the schedule calculation. The abbreviation "ddmmmyy" refers to a date format that shall translate a date into two numbers for the day, three letters for the month, and two numbers for the year. For example, March 1, 1999 shall be translated into 01Mar99. This same convention for date formats shall be used throughout the entire data format. To insure that dates are translated consistently, the following abbreviations shall be used for the three character month code: JAN, FEB, MAR, APR, MAY, JUN, JUL, AUG, SEP, OCT, NOV, DEC.

(3) The PROJECT IDENTIFIER is a maximum of four character abbreviation for the schedule. These four characters shall be used to uniquely identify the project and specific update as agreed upon by the Contractor and Contracting Officer. When utilizing scheduling software these four characters shall be used to select the project. Software manufacturers' shall verify that data importing programs do not automatically overwrite other schedules with the same PROJECT IDENTIFIER.

(4) The PROJECT NAME field shall contain the name and location of the project edited to fit the space provided. The data appearing here shall appear on scheduling software reports. The abbreviation "Alpha.", used throughout paragraph: RECORD DESCRIPTIONS, refers to an "Alphanumeric" field value.

(5) The CONTRACTOR NAME field shall contain the Construction Contractor's name edited to fit the space provided.

(6) The ARROW OR PRECEDENCE field shall indicate which method shall be used for calculation of the schedule. The value "A" shall signify the Arrow Diagraming Technique. The value "P" shall signify the Precedence Diagraming technique. The ACTIVITY IDENTIFICATION field of the Activity Record shall be interpreted differently depending on the value of this field. The Precedence Record shall be required if the value of this field is "P".

(7) The CONTRACT NUMBER field shall directly identify the contract for the project. For example, a complete government construction contract number, "DACA56-93-C-0001", shall be entered into this field as "930001".

(8) The PROJECT START shall contain the date that the project will start or has started. On government construction projects, this date is the date that the construction Contractor acknowledges the Notice to Proceed.

(9) The PROJECT END shall contain the data that the contract must complete on or prior to. On Government construction projects, this date is the PROJECT START plus the contract period, typically expressed in a specific number of calendar days.

c. Calendar Record: The Calendar Record(s) shall follow the Project Identifier Record in every data file. A minimum of one Calendar Record shall be required for all data exchange activity files. The format for the Calendar Record shall be as follows:

Description	Column Position	Max. Len.	Reqd. Value	Type	Just.
RECORD IDENTIFIER	1- 4	4	CLDR	Fixed	
CALENDAR CODE	6- 6	1		Alpha.	Filled
WORKDAYS	8- 14	7	SMTWTFS	See (3)	
CALENDAR DESCRIPTION	16- 45	30		Alpha.	Left

(1) The RECORD IDENTIFIER shall always begin with "CLDR" to identify it as a Calendar Record. Each Calendar Record used shall have this identification in the first four columns.

(2) The CALENDAR CODE shall be used in the activity records to signify that this calendar is associated with the activity.

(3) The WORKDAYS field shall contain the work-week pattern selected with "Y", for Yes, and "N", for No. The first character shall be Sunday and the last character Saturday. An example of a typical five day work-week would be NYYYYYN. A seven day work-week would be YYYYYYY.

(4) The CALENDAR DESCRIPTION shall be used to briefly explain the calendar used.

d. Holiday Record: Optional Holiday Record(s) shall follow the Calendar Record(s). The Holiday Record shall be used to designate specific non-work days for a specific Calendar. More than one Holiday Record may be used for a particular calendar. If used, the following format shall be followed:

Description	Column Position	Max. Len.	Reqd. Value	Type	Just.
RECORD IDENTIFIER	1- 4	4	HOLI	Fixed	
CALENDAR CODE	6- 6	1		Alpha.	Filled
HOLIDAY DATE	8- 14	7		ddmmmyy	Filled
HOLIDAY DATE	16-22	7		ddmmmyy	Filled
HOLIDAY DATE	24-30	7		ddmmmyy	Filled
HOLIDAY DATE	32-38	7		ddmmmyy	Filled
HOLIDAY DATE	40-46	7		ddmmmyy	Filled
HOLIDAY DATE	48-54	7		ddmmmyy	Filled
HOLIDAY DATE	56-62	7		ddmmmyy	Filled
HOLIDAY DATE	64-70	7		ddmmmyy	Filled
HOLIDAY DATE	72-78	7		ddmmmyy	Filled
HOLIDAY DATE	80-86	7		ddmmmyy	Filled
HOLIDAY DATE	88-94	7		ddmmmyy	Filled
HOLIDAY DATE	96-112	7		ddmmmyy	Filled
HOLIDAY DATE	114-120	7		ddmmmyy	Filled
HOLIDAY DATE	122-128	7		ddmmmyy	Filled

(1) The RECORD IDENTIFIER shall always begin with "HOLI" and shall signify an Optional Holiday Calendar is to be used.

(2) The CALENDAR CODE indicates which work-week calendar the holidays shall be applied to. More than one HOLI record may be used for a given CALENDAR CODE.

(3) The HOLIDAY DATE is to be used for each date to be designated as a non-work day.

e. Activity Records: Activity Records shall follow any Holiday Record(s). If there are no Holiday Record(s), then the Activity Records shall follow the Calendar Record(s). There shall be one Activity Record for every activity in the network. Each activity shall have one record in the following format:

Description	Column Position	Max. Len.	Reqd. Value	Type	Just.
RECORD IDENTIFIER	1- 4	4	ACTV	Fixed	
ACTIVITY IDENTIFICATION	6- 15	10		See (2)	
ACTIVITY DESCRIPTION	17- 46	30		Alpha.	Left
ACTIVITY DURATION	48- 50	3		Integer	Right
ACTIVITY COST	52- 60	9		Integer	Right
CONSTRAINT DATE	62- 68	7			Filled
CONSTRAINT TYPE	70- 71	2		See (7)	
CALENDAR CODE	73- 73	1		Alpha.	Filled
HAMMOCK CODE	75- 75	1	Y,blank	Fixed	
WORKERS PER DAY	77- 79	3		Integer	Right
RESPONSIBILITY CODE	81- 84	4		Alpha.	Left
WORK AREA CODE	86- 89	4		Alpha.	Left
MOD OR CLAIM NUMBER	91- 94	4		Alpha.	Left
BID ITEM	96- 99	4		Alpha.	Left
UCI CODE	101-105	5		See (15)	
USER DEFINED 1	107-110	4		See (16)	
USER DEFINED 2	112-115	4		See (16)	
USER DEFINED 3	117-120	4		See (16)	
USER DEFINED 4	122-125	4		See (16)	
USER DEFINED 5	127-130	4		See (16)	

(1) The RECORD IDENTIFIER for each activity description record must begin with the four character "ACTV" code. This field shall be used for both the Arrow Diagram Method (ADM) and Precedence Diagram Method (PDM)

(2) The ACTIVITY IDENTIFICATION consists of coding that differs, depending on whether the ADM or PDM method was selected in the Project Record. If the ADM method was selected, then the field shall be interpreted as two right-justified fields of five integers each. If the PDM method was selected, the field shall be interpreted as one right-justified field of ten integers each. The maximum activity number allowed under this arrangement is 99999 for ADM and 9999999999 for the PDM method.

(3) The ACTIVITY DESCRIPTION shall be a maximum of 30 characters. Descriptions must be limited to the space provided.

(4) The ACTIVITY DURATION contains the estimated duration for the activity on the schedule. The duration shall be based upon the work-week designated by the activity's related calendar.

(5) The ACTIVITY COST contains the estimated earned value of the work to be accomplished in the activity.

(6) The CONSTRAINT DATE field shall be used to identify a date that the scheduling system may use to modify float calculations. If there is a date in this field, then there must be a valid entry in the CONSTRAINT TYPE field. The CONSTRAINT DATE shall be the same as, or later than, the PROJECT START DATE. The CONSTRAINT DATE shall be the same as, or earlier than, the PROJECT END DATE.

(7) The CONSTRAINT TYPE field shall be used to identify the way that the scheduling system shall use the CONSTRAINT DATE to modify schedule float calculations. If there is a value in this field, then there must be a valid entry in the CONSTRAINT DATE field. Below are the minimum list of entries for the CONSTRAINT TYPE. Other types may be available from specific software manufacturers.

Code	Definition
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ES	The CONSTRAINT DATE shall replace an activity's early start date, if the early start date is prior to the CONSTRAINT DATE.
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LF	The CONSTRAINT DATE shall replace an activity's late finish date, if the late finish date is after the CONSTRAINT DATE.
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(8) The CALENDAR CODE, as previously explained, relates this activity to an appropriate work-week calendar. The ACTIVITY DURATION must be based on the valid work-week referenced by this CALENDAR CODE field.

(9) The HAMMOCK CODE indicates that a particular activity does not have its own independent duration, but takes its start dates from the start date of the preceding activity (or node) and takes its finish dates from the finish dates of its succeeding activity (or node). If the value of the HAMMOCK ACTIVITY field is "Y", then the activity is a HAMMOCK ACTIVITY.

(10) The WORKERS PER DAY is an optional field that shall be specified at the discretion of the Field Operating Agency (FOA). This field shall contain the average number of workers expected to work on the activity each day the activity is in progress. The total duration times the average number of workers per day shall equal the Contractor's estimate of the total man days of work required to perform the activity.

(11) The RESPONSIBILITY CODE shall identify the Subcontractor or major trade involved with completing the work for the activity.

(12) The WORK AREA CODE shall identify the location of the activity within the project.

(13) The MOD OR CLAIM NUMBER code is an optional field that shall be specified at the discretion of the FOA. This code shall uniquely identify activities that are changed on a construction contract modification, or activities that justify any claimed time extensions.

(14) The BID ITEM field is an optional field that shall be specified at the discretion of the FOA. This field shall designate the bid item number associated with the activity.

(15) The Construction Specification Institute (CSI) Masterformat CODE is an optional field that shall be specified at the discretion of the FOA. The CSI CODE shall contain the value of code corresponding to the work to be accomplished in this activity.

(16) USER DEFINED fields are optional and not required to meet the data exchange standard. They are provided to allow for a fixed expansion of capabilities for individual very large projects that may require additional fields.

f. Precedence Record: The Precedence Record(s) shall follow the Activity Records if a Precedence Type Schedule (PDM) is identified in the ARROW OR PRECEDENCE field of the Project Record. The Precedence Record has the following format:

Description	Column Position	Max. Len.	Reqd. Value	Type	Just.
RECORD IDENTIFIER	1- 4	4	PRED	Fixed	
ACTIVITY IDENTIFICATION	6- 15	10		Integer	See (2)
PRECEDING ACTIVITY	17- 26	10		Integer	
PREDECESSOR TYPE	28- 29	2		See (4)	
LAG DURATION	31- 34	4		Integer	Right

(1) The RECORD IDENTIFIER shall begin with the four character "PRED" in the first four columns of the record.

(2) The ACTIVITY IDENTIFICATION identifies the activity whose predecessor shall be specified in this record. Refer to the Activity Record for further explanation on this field.

(3) The PREDECESSOR ACTIVITY number is the number of an activity that precedes the activity noted in the ACTIVITY IDENTIFICATION field.

(4) The PREDECESSOR TYPE field indicates the type of relationship that exists between the chosen pair of activities. The PREDECESSOR TYPE field must, as a minimum, contain one of the codes listed below. Other types of activity relations may be supported from specific software vendors.

Code	Definition
SS	Start-to-Start relationship
FF	Finish-to-Finish relationship
FS	Finish-to-Start relationship



(5) The LAG DURATION field contains the number of days delay between the preceding and current activity.

g. Unit Cost Record: The Unit Cost Record shall follow all Precedence Records. If the schedule utilizes the Arrow Diagram Method, then the Unit Cost Record shall follow any Activity Records. The fields for this record shall take the following format:

Description	Column Position	Max. Len.	Reqd. Value Type	Just.
RECORD IDENTIFIER	1- 4	4	UNIT Fixed	
ACTIVITY IDENTIFICATION	6- 15	10	Integer	See (2)
TOTAL QTY	17- 27	11	Floating Pt.	
COST PER UNIT	29- 39	11	Floating Pt.	
QTY TO DATE	41- 51	11	Floating Pt.	
UNIT OF MEASURE	53- 55	3	Alpha.	

(1) The RECORD IDENTIFIER shall be identified with the four character "UNIT" placed in the first four columns of the record.

(2) The ACTIVITY IDENTIFICATION for each activity shall match the format described in the activity record.

(3) The TOTAL QTY is the total amount of this type of material to be used in this activity. This number consists of eight digits, one decimal point, and two more digits. An example of a number in this format is "11111111.11". If decimal places are not needed, this field shall still contain a ".00" in columns 25, 26, and 27.

(4) The COST PER UNIT is the cost, in dollars and cents, for each unit to be used in this activity. This number consists of eight digits, one decimal point, and two more digits. An example of a number in this format is "11111111.11". If decimal places are not needed, this field shall still contain a ".00" in columns 37, 38, and 39.

(5) The QTY TO DATE is the quantity of material installed in this activity up to the data date. This number consists of eight digits, one decimal point, and two more digits. An example of a number in this format is "11111111.11". If decimal places are not needed, this field shall still contain a ".00" in columns 49, 50, and 51.

(6) The UNIT OF MEASURE is an abbreviation that may be used to describe the units being measured for this activity.

h. Progress Record: Progress Record(s) shall follow all Unit Cost Record(s). If there are no Unit Cost Record(s), then the Progress Record(s) shall follow all Precedence Records. If the schedule utilizes the Arrow Diagram Method, then the Progress Record shall follow any Activity Records. One Record shall exist for each activity in-progress or completed. The fields for this Record shall take the following format:

Description	Column Position	Max. Len.	Reqd. Value Type	Just.
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RECORD IDENTIFIER	1- 4	4	PROG	Fixed	
ACTIVITY IDENTIFICATION	6- 15	10		Integer	See (20)
ACTUAL START DATE	17- 23	7		ddmmmyy	Full
ACTUAL FINISH DATE	25- 31	7		ddmmmyy	Full
REMAINING DURATION	33- 35	3		Integer	Right
COST TO DATE	37- 45	9		Integer	Right

(1) The RECORD IDENTIFIER shall begin with the four character "PROG" in the first four columns of the record.

(2) The ACTIVITY IDENTIFICATION for each activity for which progress has been posted, shall match the format described in the Activity Record.

(3) An ACTUAL START DATE is required for all in-progress activities. The ACTUAL START DATE shall be the same as, or later than, the PROJECT START date contained in the Project Record. The ACTUAL START DATE shall also be the same as, or prior to, the DATA DATE contained in the Project record.

(4) An ACTUAL FINISH DATE is required for all completed activities. If the REMAINING DURATION of an activity is zero, then there must be an ACTUAL FINISH DATE. The ACTUAL FINISH DATE must be the same as, or later than the PROJECT START date contained in the Project Record. The ACTUAL FINISH DATE must also be the same as, or prior to the DATA DATE contained in the Project Record.

(5) A REMAINING DURATION is required for all in-progress activities. Activities completed, based on time, shall have a zero REMAINING DURATION.

(6) Cost progress is contained in the field COST TO DATE. If there is an ACTUAL START DATE, then there must also be some value for COST TO DATE. The COST TO DATE is not tied to REMAINING DURATION. For example, if the REMAINING DURATION is "0", the COST TO DATE may only be 95% of the ACTIVITY COST. This difference may be used to reflect 5% retainage for punch list items.

i. File End Record:

(1) The File End Record shall be used to identify that the data file is completed. This record shall be the last record of the entire data file. The File End Record shall have the following format:

Description	Column Position	Max. Len.	Reqd. Value Type	Just.
RECORD IDENTIFIER	1- 3	3	END Fixed	

(2) The RECORD IDENTIFIER for the File End Record shall be "END". No data contained in the data exchange file that occurs after this record is found shall be used.

## SECTION 01415

## METRIC MEASUREMENTS

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 380	(1993) Practice for Use of the International System of Units (SI)
ASTM E 621	(1994) Practice for Use of Metric (SI) Units in Building Design and Construction

## 1.2 GENERAL

This project includes metric units of measurements. The metric units used are the International System of Units (SI) developed and maintained by the General Conference on Weights and Measures (CGPM); the name International System of Units and the international abbreviation SI were adopted by the 11th CGPM in 1960. A number of circumstances require that both metric SI units and English inch-pound (I-P) units be included in a section of the specifications. When both metric and I-P measurements are included, the section may contain measurements for products that are manufactured to I-P dimensions and then expressed in mathematically converted metric value (soft metric) or, it may contain measurements for products that are manufactured to an industry recognized rounded metric (hard metric) dimensions but are allowed to be substituted by I-P products to comply with the law. Dual measurements are also included in select locations to indicate industry and/or Government standards, test values or other controlling factors, such as the code requirements where I-P values are needed for clarity or to trace back to the referenced standards, test values or codes.

## 1.3 USE OF MEASUREMENTS

Measurements shall be either in SI or I-P units as indicated, except for soft metric measurements or as otherwise authorized. When only SI or I-P measurements are specified for a product, the product shall be procured in the specified units (SI or I-P) unless otherwise authorized by the Contracting Officer. The Contractor shall be responsible for all associated labor and materials when authorized to substitute one system of units for another and for the final assembly and performance of the specified work and/or products.

## 1.3.1 Hard Metric

A hard metric measurement is indicated by an SI value with no expressed correlation to an I-P value, i.e., where an SI value is not an exact mathematical conversion of an I-P value, such as the use of 100 mm in lieu of 4 inches. Hard metric measurements are often used for field data such as

distance from one point to another or distance above the floor. Products are considered to be hard metric when they are manufactured to metric dimensions or have an industry recognized metric designation.

#### 1.3.2 Soft Metric

- a. A soft metric measurement is indicated by an SI value which is a mathematical conversion of the I-P value shown in parentheses (e.g. 38.1 mm (1-1/2 inches)). Soft metric measurements are used for measurements pertaining to products, test values, and other situations where the I-P units are the standard for manufacture, verification, or other controlling factor. The I-P value shall govern while the metric measurement is provided for information.
- b. A soft metric measurement is also indicated for products that are manufactured in industry designated metric dimensions but are required by law to allow substitute I-P products. These measurements are indicated by a manufacturing hard metric product dimension followed by the substitute I-P equivalent value in parentheses (e.g., 190 x 190 x 390 mm (7-5/8 x 7-5/8 x 15-5/8 inches)).

#### 1.3.3 Neutral

A neutral measurement is indicated by an identifier which has no expressed relation to either an SI or an I-P value (e.g., American Wire Gage (AWG) which indicates thickness but in itself is neither SI nor I-P).

#### 1.4 COORDINATION

Discrepancies, such as mismatches or product unavailability, arising from use of both metric and non-metric measurements and discrepancies between the measurements in the specifications and the measurements in the drawings shall be brought to the attention of the Contracting Officer for resolution.

#### 1.5 RELATIONSHIP TO SUBMITTALS

Submittals for Government approval or for information only shall cover the SI or I-P products actually being furnished for the project. The Contractor shall submit the required drawings and calculations in the same units used in the contract documents describing the product or requirement unless otherwise instructed or approved. The Contractor shall use ASTM E 380 and ASTM E 621 as the basis for establishing metric measurements required to be used in submittals.

#### 2 PRODUCTS (NOT APPLICABLE)

#### 3 EXECUTION (NOT APPLICABLE)

## SECTION 01440

## CONTRACTOR QUALITY CONTROL

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 3740 (1994a) Evaluation of Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

ASTM E 329 (1993b) Use in the Evaluation of Testing and Inspection Agencies as Used in Construction

## 1.2 PAYMENT

Separate payment will not be made for providing and maintaining an effective Quality Control program, and all costs associated therewith shall be included in the applicable unit prices or lump-sum prices contained in the Bidding Schedule.

## 2 PRODUCTS (NOT APPLICABLE)

## 3 EXECUTION

## 3.1 GENERAL

The Contractor is responsible for quality control and shall establish and maintain an effective quality control system in compliance with the Contract Clause entitled "INSPECTION OF CONSTRUCTION." The quality control system shall consist of plans, procedures, and organization necessary to produce an end product which complies with the contract requirements. The system shall cover all construction operations, both on-site and off-site, and shall be keyed to the proposed construction sequence.

## 3.2 QUALITY CONTROL PLAN

## 3.2.1 General

The Contractor shall furnish for review by the Government, not later than 30 days after receipt of notice to proceed, the Contractor Quality Control (CQC) Plan proposed to implement the requirements of the Contract Clause entitled "Inspection of Construction." The plan shall identify personnel, procedures, control, instructions, test, records, and forms to be used. The Government will consider an interim plan for the first 30 days of operation. Construction will be permitted to begin only after acceptance of the CQC Plan or acceptance of an interim plan applicable to the particular feature of work to be started. Work outside of the features of work included in an accepted interim plan will not be permitted to begin until acceptance of a

CQC Plan or another interim plan containing the additional features of work to be started.

### 3.2.2 Content of the CQC Plan

The CQC plan shall include, as a minimum, the following to cover all construction operations, both on-site and off-site, including work by subcontractors, fabricators, suppliers and purchasing agents:

a. A description of the quality control organization, including a chart showing lines of authority and acknowledgment that the CQC staff shall implement the three phase control system for all aspects of the work specified. The staff shall include a CQC system manager who shall report to the project manager or someone higher in the Contractor's organization. Project manager in this context shall mean the individual with responsibility for the overall management of the project including quality and production.

b. The name, qualifications (in resume format), duties, responsibilities, and authorities of each person assigned a CQC function.

c. A copy of the letter to the CQC System Manager signed by an authorized official of the firm which describes the responsibilities and delegates sufficient authorities to adequately perform the functions of the CQC System Manager including authority to stop work which is not in compliance with the contract. The CQC System Manager shall issue letters of direction to all other various quality control representatives outlining duties, authorities and responsibilities. Copies of these letters will also be furnished to the Government.

d. Procedures for scheduling, reviewing, certifying, and managing submittals, including those of subcontractors, off-site fabricators, suppliers and purchasing agents. These procedures shall be in accordance with Section 01300 SUBMITTAL DESCRIPTIONS.

e. Control, verification and acceptance testing procedures for each specific test to include the test name, specification paragraph requiring test, feature of work to be tested, test frequency, and person responsible for each test. (Laboratory facilities will be approved by the Contracting Officer.)

f. Procedures for tracking preparatory, initial, and follow-up control phases and control, verification, and acceptance tests including documentation.

g. Procedures for tracking construction deficiencies from identification through acceptable corrective action. These procedures will establish verification that identified deficiencies have been corrected.

h. Reporting procedures, including proposed reporting formats.

i. A list of the definable features of work. A definable feature of work is a task which is separate and distinct from other tasks and has separate control requirements. It could be identified by different trades or disciplines, or it could be work by the same trade in a

different environment. Although each section of the specifications may generally be considered as a definable feature of work, there are frequently more than one definable feature under a particular section. This list will be agreed upon during the coordination meeting.

### 3.2.3 Acceptance of Plan

Acceptance of the Contractor's plan is required prior to the start of construction. Acceptance is conditional and will be predicated on satisfactory performance during the construction. The Government reserves the right to require the Contractor to make changes in his CQC plan and operations including removal of personnel, as necessary, to obtain the quality specified.

### 3.2.4 Notification of Changes

After acceptance of the QC plan, the Contractor shall notify the Contracting Officer in writing a minimum of seven calendar days prior to any proposed change. Proposed changes are subject to acceptance by the Contracting Officer.

## 3.3 COORDINATION MEETING

After the Preconstruction Conference, before start of construction, and prior to acceptance by the Government of the Quality Control Plan, the Contractor shall meet with the Contracting Officer or Authorized Representative and discuss the Contractor's quality control system. During the meeting, a mutual understanding of the system details shall be developed, including the forms for recording the CQC operations, control activities, testing, administration of the system for both on-site and off-site work, and the interrelationship of Contractor's Management and control with the Government's Quality Assurance. Minutes of the meeting shall be prepared by the Government and signed by both the Contractor and the Contracting Officer. The minutes shall become a part of the contract file. There may be occasions when subsequent conferences will be called by either party to reconfirm mutual understandings and/or address deficiencies in the CQC system or procedures which may require corrective action by the Contractor.

## 3.4 QUALITY CONTROL ORGANIZATION

### 3.4.1 CQC System Manager

The Contractor shall identify an individual within his organization at the site of the work who shall be responsible for overall management of CQC and have the authority to act in all CQC matters for the Contractor. This CQC System Manager shall be on the site at all times during construction and will be employed by the Contractor, except as noted in the following. An alternate for the CQC System Manager will be identified in the plan to serve in the event of the system manager's absence. Period of absence may not exceed two weeks at any one time, and not more than 45 workdays during a calendar year. The requirements for the alternate will be the same as for the designated CQC manager.

### 3.4.2 CQC Organization Staffing

The Contractor shall provide a CQC staff which shall be at the site of work at all times during progress, with complete authority to take any action necessary to ensure compliance with the contract.

#### 3.4.2.1 CQC Staff

Following are the minimum requirements for the CQC staff. These minimum requirements will not necessarily assure an adequate staff to meet the CQC requirements at all times during construction. The actual strength of the CQC staff may vary during any specific work period to cover the needs of the work period. When necessary for a proper CQC organization, the Contractor will add additional staff at no cost to the Government. This listing of minimum staff in no way relieves the Contractor of meeting the basic requirements of quality construction in accordance with contract requirements. All CQC staff members shall be subject to acceptance by the Contracting Officer.

#### 3.4.2.2 CQC System Manager

The system manager shall be a graduate engineer or architect having five years of experience on construction of a type similar to this contract, including one year of experience in quality control or an engineering technician with a minimum of 10 years (documented) experience on similar type construction including four years experience in quality control. The CQC system manager shall be assigned no other duties.

#### 3.4.2.3 Supplemental Personnel

The Contractor shall provide as part of the CQC organization, as a minimum, specialized personnel in the areas of electrical, mechanical, civil, and structural, environmental, and architectural as applicable. These personnel shall assist and report to the CQC system manager. Each person's sole responsibility shall be to assure that construction complies with the contract requirements for their area of specialization. These individuals shall: be employed or contracted directly with the prime contractor and not a part of the subcontractor's organization engaged in performing the construction; be physically present at the construction site a minimum of one day per week or more often as necessary to ensure contract compliance; have the necessary education or experience to ensure contract compliance. Physical presence shall begin when each discipline of work begins on site. In addition, these individuals shall be a part of the submittal review process and shall sign the applicable submittal prior to Submission to the Government.

#### 3.4.2.4 Training

In addition to the above experience and education requirements the CQC System Manager or the principal member of the CQC staff shall attend an 8 hour training course on "Construction Quality Management." This course will be periodically offered by the Corps of Engineers and times, dates and location will be provided at the Pre-construction Conference.

### 3.5 CONTROL

Contractor Quality Control is the means by which the Contractor ensures that the construction, to include that of subcontractors and suppliers, complies with the requirements of the contract. The controls shall be adequate to



cover all construction operations, including both on-site and off-site fabrication, and will be keyed to the proposed construction sequence. The controls shall include at least three phases of control to be conducted by the CQC system manager for all definable features of work, as follows:

#### 3.5.1 Preparatory Phase

This phase shall be performed prior to beginning work on each definable feature of work and shall include:

- a. A review of each paragraph of applicable specifications.
- b. A review of the contract plans.
- c. A check to assure that all materials and/or equipment have been tested, submitted, and approved.
- d. A check to assure that provisions have been made to provide required control inspection and testing.
- e. Examination of the work area to assure that all required preliminary work has been completed and is in compliance with the contract.
- f. A physical examination of required materials, equipment, and sample work to assure that they are on hand, conform to approved shop drawing or submitted data, and are properly stored.
- g. A review of the appropriate activity hazard analysis to assure safety requirements are met.
- h. Discussion of procedures for constructing the work including repetitive deficiencies. Document construction tolerances and workmanship standards for that phase of work.
- i. A check to ensure that the portion of the plan for the work to be performed has been accepted by the Contracting Officer.

The Government shall be notified at least 24 hours in advance of beginning any of the required action of the preparatory phase. This phase shall include a meeting conducted by the CQC system manager and attended by the superintendent, other CQC personnel (as applicable), and the foreman responsible for the definable feature. The results of the preparatory phase actions shall be documented by separate minutes prepared by the CQC system manager and attached to the daily CQC report. The Contractor shall instruct applicable workers as to the acceptable level of workmanship required in order to meet contract specifications.

#### 3.5.2 Initial Phase

This phase shall be accomplished at the beginning of a definable feature of work. The following shall be accomplished:

- a. A check of preliminary work to ensure that it is in compliance with contract requirements. Review minutes of the preparatory meeting.

- b. Verification of full contract compliance. Verify required control inspection and testing.
- c. Establish level of workmanship and verify that it meets minimum acceptable workmanship standards. Compare with sample panels is appropriate.
- d. Resolve all differences.
- e. Check safety to include compliance with and upgrading of the safety plan and activity hazard analysis. Review the activity analysis with each worker.

The Government shall be notified at least 24 hours in advance of beginning the initial phase. Separate minutes of this phase shall be prepared by the CQC system manager and attached to the daily QC report. Exact location of initial phase shall be indicated for future reference and comparison with follow-up phases. The initial phase should be repeated for each new crew to work on-site, or any time acceptable specified quality standards are not being met.

### 3.5.3 Follow-up Phase

Daily checks shall be performed to assure continuing compliance with contract requirements, including control testing, until completion of the particular feature of work. The checks shall be made a matter of record in the CQC documentation. Final follow-up checks shall be conducted and all deficiencies corrected prior to the start of additional features of work which may be affected by the deficient work. The Contractor shall not build upon or conceal non-conforming work.

### 3.5.4 Additional Preparatory and Initial Phases

Additional preparatory and initial phases may be conducted on the same definable features of work as determined by the Government if the quality of on-going work is unacceptable; or if there are changes in the applicable QC staff or in the on-site production supervision or work crew; or if work on a definable feature is resumed after a substantial period of inactivity, or if other problems develop.

## 3.6 TESTS

### 3.6.1 Testing Procedure

The Contractor shall perform tests specified or required to verify that control measures are adequate to provide a product which conforms to contract requirements. Testing includes operation and/or acceptance tests when specified. The Contractor shall procure the services of a Corps of Engineers approved testing laboratory or establish an approved testing laboratory at the project site. The Contractor shall perform the following activities and record and provide the following data:

- a. Verify that testing procedures comply with contract requirements.
- b. Verify that facilities and testing equipment are available and comply with testing standards.

- c. Check test instrument calibration data against certified standards.
- d. Verify that recording forms and test identification control number system, including all of the test documentation requirements, have been prepared.
- e. Results of all tests taken, both passing and failing tests, will be recorded on the Quality Control report for the date taken. Specification paragraph reference, location where tests were taken, and the sequential control number identifying the test will be given. Actual test reports may be submitted later, if approved by the Contracting Officer, with a reference to the test number and date taken. An information copy of tests performed by an off-site or commercial test facility will be provided directly to the Contracting Officer. Failure to submit timely test reports, as stated, may result in nonpayment for related work performed and disapproval of the test facility for this contract.

### 3.6.2 Testing Laboratories

#### 3.6.2.1 Capability Check

The Government reserves the right to check laboratory equipment in the proposed laboratory for compliance with the standards set forth in the contract specifications and to check the laboratory technician's testing procedures and techniques. Laboratories utilized for testing soils, concrete, asphalt and steel shall meet criteria detailed in ASTM D 3740 and ASTM E 329.

#### 3.6.2.2 Capability Recheck

If the selected laboratory fails the capability check, the Contractor will be assessed a charge of \$500.00 to reimburse the Government for each succeeding recheck of the laboratory or the checking of a subsequently selected laboratory. Such costs will be deducted from the contract amount due the Contractor.

### 3.6.3 On-Site Laboratory

The Government reserves the right to utilize the Contractor's control testing laboratory and equipment to make assurance tests and to check the Contractor's testing procedures, techniques, and test results at no additional cost to the Government.

### 3.6.4 Furnishing or Transportation of Samples for Testing

Costs incidental to the transportation of samples or materials will be borne by the Contractor. Samples of materials for test verification and acceptance testing by the Government shall be delivered to a Corps of Engineers Division Laboratory as directed by the Contracting Officer.

Coordination for each specific test, exact delivery location and dates will be made through the Area Office.

### 3.7 COMPLETION INSPECTION

At the completion of all work or any increment thereof established by a completion time stated in the Special Contract Requirements entitled "Commencement, Prosecution, and Completion of Work," or stated elsewhere in the specifications, the CQC system manager shall conduct an inspection of the work and develop a "punch list" of items which do not conform to the approved plans and specifications. Such a list of deficiencies shall be included in the CQC documentation, as required by paragraph DOCUMENTATION below, and shall include the estimated date by which the deficiencies will be corrected. The CQC system manager or staff shall make a second inspection to ascertain that all deficiencies have been corrected and so notify the Government. These inspections and any deficiency corrections required by this paragraph will be accomplished within the time stated for completion of the entire work or any particular increment thereof if the project is divided into increments by separate completion dates.

### 3.8 DOCUMENTATION

The Contractor shall maintain current records of quality control operations, activities, and tests performed, including the work of subcontractors and suppliers. These records shall be on an acceptable form and shall include factual evidence that required quality control activities and/or tests have been performed, including but not limited to the following:

- a. Contractor/subcontractor and their area of responsibility.
- b. Operating plant/equipment with hours worked, idle, or down for repair.
- c. Work performed each day, giving location, description, and by whom. When Network Analysis (NAS) is used, identify each phase of work performed each day by NAS activity number.
- d. Test and/or control activities performed with results and references to specifications/plan requirements. The control phase should be identified (Preparatory, Initial, Follow-up). List deficiencies noted along with corrective action.
- e. Material received with statement as to its acceptability and storage.
- f. Submittals reviewed, with contract reference, by whom, and action taken.
- g. Off-site surveillance activities, including actions taken.
- h. Job safety evaluations stating what was checked, results, and instructions or corrective actions.
- i. Instructions given/received and conflicts in plans and/or specifications.
- j. Contractor's verification statement.
- k. These records shall indicate a description of trades working on the project; the number of personnel working; weather conditions

encountered; and any delays encountered. These records shall cover both conforming and deficient features and shall include a statement that equipment and materials incorporated in the work and workmanship comply with the contract. The original and one copy of these records in report form shall be furnished to the Government the first workday following the report, except that reports need not be submitted for days on which no work is performed. As a minimum, one report shall be prepared and submitted for every seven days of no work and on the last day of a no work period. All calendar days shall be accounted for throughout the life of the contract. The first report following a day of no work shall be for that day only. Reports shall be signed and dated by the CQC system manager. The report from the CQC system manager shall include copies of test reports and copies of reports prepared by all subordinate quality control personnel.

### 3.9 SAMPLE FORMS

Sample forms are enclosed at the end of this section.

### 3.10 NOTIFICATION OF NONCOMPLIANCE

The Contracting Officer will notify the Contractor of any detected noncompliance with the foregoing requirements. The Contractor shall, after receipt of such notice, immediately take corrective action. Such notice, when delivered to the Contractor at the site of the work, shall be deemed sufficient for the purpose of notification. If the Contractor fails or refuses to comply promptly, the Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to such stop orders shall be made the subject of claim for extension of time or for excess costs or damages by the Contractor.

### 3.11 RESIDENT MANAGEMENT SYSTEM (RMS)

The Contractor shall implement the Resident Management system (RMS) computer program software for generating and maintaining the Contractor's Daily Quality Control Reports and other project information. The Government will provide the Contractor with the software at no charge and will assist in on-site training and program support.

The program shall be used to document and maintain the following information:

Prime Contractor staffing and subcontractor data

Insurance expiration dates

Definable features of work (items requiring a preparatory inspection) with pay activities and activity number, and the value, duration, start and finish dates , subcontractor, and bid item reference for each activity

Quality control tests

Planned training

Installed property list

Submittal information including specification section, description, time required for procurement and days of float for material need-by dates, all tied to activity number.

Progress earnings. The sum of all activity values shall equal the contract amount and bid items shall be separately identified in accordance with the Bidding Schedule and the total contract amount. All information shall be maintained current and submitted to the Government weekly.

The RMS shall document deficiency reports from the Government and shall state outstanding or future required corrections. The shall indicate the deficiency report on the Daily Quality Control Report and shall record corrections made in the RMS.

## DAILY CONSTRUCTION QUALITY CONTROL REPORT

Date: \_\_\_\_\_ Report No. \_\_\_\_\_  
Contract No.: \_\_\_\_\_  
Description and Location of Work: \_\_\_\_\_  
WEATHER: (Clear) (P. Cloudy) (Cloudy); Temperature: \_\_\_\_\_ Min; \_\_\_\_\_ Max;  
Rainfall \_\_\_\_\_ Inches  
Contractor/Subcontractors and Area of Responsibility with Labor Count for Each:  
a. \_\_\_\_\_  
b. \_\_\_\_\_  
c. \_\_\_\_\_  
d. \_\_\_\_\_  
Equipment Data: (Indicate items of construction equipment, other than hand tools, at the jobsite, and whether or not used.)

1. Work Performed Today: (Indicate location and description of work performed. Refer to work performed by prime and/or subcontractors by letter in table above.)

2. Results of Surveillance: (Include satisfactory work completed, or deficiencies with action to be taken.)

a. Preparatory Inspection:

b. Initial Inspection:

c. Followup Inspections:

3. Test Required by Plans and/or Specifications Performed and Results of Tests:

4. Verbal Instructions Received: (List any instructions given by Government personnel on construction deficiencies, retesting required, etc., with action to be taken.)

5. Remarks: (Cover any conflicts in plans, specifications, or instructions or any delay to the job attributable to weather conditions.)

6. Results of Safety Inspection: (Include safety violations and corrective actions taken.)

Contractor's Inspector

CONTRACTOR'S VERIFICATION: The above report is complete and correct and all material and equipment used and work performed during this reporting period are in compliance with the contract plans and specifications except as noted above.

Contractor's Approved Authorized Representative



## PREPARATORY INSPECTION CHECKLIST

Contract No.:

Date:

Title:

Specs Section:

MAJOR DEFINABLE SEGMENT OF WORK:

A. PERSONNEL PRESENT:

NAME

POSITION

COMPANY

1.

2.

3.

4.

5.

6.

7.

8.

9.

10.

(List additional personnel on reverse side.)

B. TRANSMITTALS INVOLVED:

CONTRACTOR OR NUMBER & ITEM  
APPROVAL

CODE

GOVERNMENT

1.

2.

3.

4.

5.

6.

B-I. Have all items involved been approved?

Yes

No

B-II. What items have not been approved?

ITEM

STATUS

1.

2.

3.

4.

5.

C. ARE ALL MATERIALS ON HAND? Yes No

C-I. Are all materials on hand in accordance with approvals? Yes No

C-II. Items not on hand or not in accordance with transmittals:

1.

2.

3.

4.

D. TESTS REQUIRED IN ACCORDANCE WITH CONTRACT REQUIREMENTS:

TEST

PARAGRAPH

1.

2.

3.

E. ACCIDENT PREVENTION PREPLANNING - HAZARD CONTROL MEASURES:

E-I. Applicable Outlines (Attach Completed Copies):

1.

2.

3.

4.

5.

E-II. Operational Equipment Checklists:

ATTACHED FOR:

1.

2.

3.

ON FILE FOR:

1.

2.

3.

Quality Control - Prime Contractor

Quality Control - Work Involved

## INITIAL INSPECTION CHECKLIST

Contract No.:

Date:

Description and Location of Work Inspected:

Specs Section:

## REFERENCE CONTRACT DRAWINGS:

## A. PERSONNEL PRESENT:

	NAME	POSITION	COMPANY
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

B. MATERIALS BEING USED ARE IN STRICT COMPLIANCE WITH THE CONTRACT PLANS AND SPECIFICATIONS.                      Yes                      No    IF NOT, EXPLAIN:

C. PROCEDURES AND/OR WORK METHODS WITNESSED ARE IN STRICT COMPLIANCE WITH THE REQUIREMENTS OF THE CONTRACT SPECIFICATIONS.                      Yes                      No    IF NOT, EXPLAIN:

D. WORKMANSHIP IS ACCEPTABLE.                      Yes                      No    STATE AREAS WHERE IMPROVEMENT IS NEEDED:

E. SAFETY VIOLATIONS AND CORRECTION ACTION TAKEN:

Quality Control Representative

OPERATION AND MAINTENANCE FIELD INSTRUCTIONS

CONTRACT NO.

DESCRIPTION

LOCATION

DATE

Operation and maintenance instructions were conducted for (Type of  
Equipment)  
required by section , paragraph ,  
on . (Date)

The following personnel were present: (Signatures of Attendees)

Instructions were given by (Contractor's Representative)  
The personnel identified herein by their signatures certify that they have  
been instructed in the operation and maintenance of the above-mentioned  
equipment.

PIPING SYSTEM TEST REPORT

STRUCTURE OR BUILDING

CONTRACT NO.

DESCRIPTION OF SYSTEM OR PART OF SYSTEM TESTED:

DESCRIPTION OF TEST:

NAME AND TITLE OF PERSON IN CHARGE OF PERFORMING TESTS FOR CONTRACTOR:

NAME

TITLE

SIGNATURE

I HEREBY CERTIFY THAT THE ABOVE-DESCRIBED SYSTEM HAS BEEN TESTED AS  
INDICATED ABOVE AND FOUND TO BE ENTIRELY SATISFACTORY AS REQUIRED IN THE  
CONTRACT SPECIFICATIONS.

(SIGNATURE OF INSPECTOR)

(DATE)

REMARKS:

## CONTRACTOR'S INSPECTOR ROOFING CHECKLIST AND TEST REPORT

DATE:

WEATHER:

CONTRACT NO.:

All data required to be taken from labels on container.

1. Type of bitumen used with underlayment or insulation and area covered
2. Type of bitumen used with base sheet and area covered
3. Type of bitumen used for mopping 4 plies
4. Type of bitumen used for flood coat or surfacing gravel
5. Type and thickness of insulation or underlayment used
6. Type of base sheet used
7. Type of felt used
8. Source of surface gravel and condition, wet, dry, clean
9. Roofing sample(s), location and weight
10. Bitumen sample furnished to the Government, quantity and type
11. Bitumen temperature checks, type of asphalt, time taken, maximum temperature specified
12. Are brooms being used?                      Yes                      No.
13. Bituminous cement used, type and usage
14. Area covered

Contractor's Approved Authorized  
Representative

Quality Control Inspector

## SECTION 01500

## CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

## 1 GENERAL

## 1.1 AVAILABILITY AND USE OF UTILITY SERVICES (APR 1994) (FAR 52.236-14)

## 1.1.1 Availability

The Government will make available to the Contractor, from existing outlets and supplies, all reasonably required amounts of utilities as specified in the Contract. Unless otherwise provided in the contract, the amount of each utility service consumed shall be charged to or paid for by the Contractor at prevailing rates charged to the Government or, where the utility is produced by the Government, at reasonable rates determined by the Contracting Officer. The Contractor shall carefully conserve any utilities furnished without charge.

## 1.1.2 Use

The Contractor, at its expense and in a workmanlike manner satisfactory to the Contracting Officer, shall install and maintain all necessary temporary connections and distribution lines, and all meters required to measure the amount of each utility used for the purpose of determining charges. Before final acceptance by the Government, the Contractor shall remove all the temporary connections, distribution lines, meters, and associated paraphernalia.

## 1.2 PAYMENT FOR UTILITY SERVICES (APR 1984)

Water, gas, and electricity are available from Government-owned and -operated systems and will be charged to the Contractor at rates as provided in the paragraph "Availability and Use of Utility Services."

Utilities shall be paid for by the Contractor at the following rates:

Utility Service	Unit Quantity	Cost (\$)
Electricity	KWH	0.0268
Natural Gas	1,000 CF	4.4814
Water	1,000 Gal	0.7170
Sewage Treatment	1,000 Gal	2.3991
Sanitary landfill	Ton	10.0
Rubble Pit	Ton	6.0
Asbestos Waste	Ton	36.0
Lead Waste (DRMO)	Pound	0.2500
Hazardous Waste (DRMO)	Pound	1.35
Contaminated Soil	Pound	0.1400

## 1.3 MOWING

Grass and weedy vegetation within the areas utilized by the Contractor, including work areas, administrative areas, and storage areas, shall be kept mowed to control vegetative growth. Vegetation shall be mowed to a height of 75 mm when it reaches a height of 150 mm. Mowing shall be done with a rotary mower. Mowing shall be done during periods and in such a manner that



the soil and grass will not be damaged. Areas adjacent to trees, shrubs, fences, buildings, etc. shall be hand trimmed. The Government may, after notice to the Contractor and at the discretion of the Contracting Officer, mow the Contractor's areas at any time the vegetation height exceeds 150 mm and all costs incurred by the Government for performing such work will be deducted from the contract.

#### 1.4 STAGING AREA PREPARATION (REQUEST BY DE, JUL 91)

The Contractor's staging area or areas shall be located within the boundaries of the project parking lots shown. The staging area(s) shall be prepared by the Contractor to the limits as required for the Contractor's temporary field office facilities, material storage, parking, Government offices, and other necessary staging activities. The Contractor shall prepare the staging area and the driveway access by grading and constructing in accordance with the plans and specifications. The parking area and drives may be constructed to pavement completion or to partial completion as desired but shall be not less than the construction of base course. The Contractor shall be responsible for the maintenance of all completed or partially completed construction and shall repair any damage prior to acceptance of the project.

#### 2 PRODUCTS (NOT APPLICABLE)

#### 3 EXECUTION (NOT APPLICABLE)

## SECTION 01561

## ENVIRONMENTAL PROTECTION

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPAPUB	(1992) NPDES (National Pollution Discharge Elimination System) General Permits for Storm Water Discharges from Construction Sites
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## 1.2 DEFINITIONS

For the purpose of this specification, environmental pollution and damage is defined as the presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances of importance to human life; affect other species of importance to man; or degrade the utility of the environment for aesthetic, cultural and/or historical purposes. The control of environmental pollution and damage requires consideration of air, water, and land, and includes management of visual aesthetics, noise, solid waste, radiant energy and radioactive materials, as well as other pollutants.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having a "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300.

## SD-01 Data

## Environmental Protection Plan

The environmental protection plan shall address all items in the paragraph ENVIRONMENTAL PROTECTION REQUIREMENTS.

## Pollution Prevention Plan; GA.

The pollution prevention plan (PPP) shall address all items in the paragraph STORM WATER POLLUTION PREVENTION PLANS. The plan shall be submitted and approved prior to the beginning of construction.

## 1.4 ENVIRONMENTAL PROTECTION REQUIREMENTS

Provide and maintain, during the life of the contract, environmental protection. Plan for and provide environmental protective measures to control pollution that develops during normal construction practice. Plan for and provide environmental protective measures required to correct conditions that develop during the construction of permanent or temporary

environmental features associated with the project. Comply with Federal, State, and local regulations pertaining to the environment, including but not limited to water, air, and noise pollution.

#### 1.4.1 Environmental Protection Plan

Within 15 days after receipt of Notice of Award of the contract and at least 7 days prior to the Preconstruction Conference, the Contractor shall submit in writing, with drawings, an Environmental Protection Plan and meet with representatives of the Contracting Officer to develop mutual understanding relative to compliance with this provision and administration of the environmental protection program. Approval of the Contractor's plan will not relieve the Contractor of his responsibility for adequate and continuing control of pollutants and other environmental protection measures. The Government reserves the right to make changes in his environmental protection plan and operations as necessary to maintain satisfactory environmental protection performance. The environmental protection plan shall include but not be limited to the following:

##### 1.4.1.1 Laws, Regulations, and Permits

Except for a Notice of Intent (NOI) required for obtaining a permit for storm water discharge which will be obtained by the Corps of Engineers, the Contractor shall prepare a list of Federal, State and local laws, regulations, and permits concerning environmental protection, pollution control and abatement that are applicable to the Contractor's proposed operations and the requirements imposed by those laws, regulations and permits.

##### 1.4.1.2 Protection of Features

The Contractor shall determine methods for the protection of features to be preserved within authorized work areas. The Contractor shall prepare a listing of methods to protect resources needing protection, i.e., trees, shrubs, vines, grasses and ground cover, landscape features, air and water quality, fish and wildlife, soil, historical, archaeological and cultural resources.

##### 1.4.1.3 Procedures

The Contractor shall implement procedures to provide the required environmental protection and to comply with the applicable laws and regulations. The Contractor shall set out the procedures to be followed to correct pollution of the environment due to accident, natural causes or failure to follow the procedures set out in accordance with the environmental protection plan.

##### 1.4.1.4 Permit or License

The Contractor shall obtain all needed permits or licenses for disposal of solid, liquid, chemical, and other waste generated as a result of this contract.

##### 1.4.1.5 Drawings

The Contractor shall include drawings showing locations of any proposed temporary excavations, material storage areas, structures, sanitary

facilities, stockpiles of earth materials, and disposal areas for excess earth material and unsatisfactory earth materials.

#### 1.4.1.6 Environmental Monitoring Plans

The Contractor shall include environmental monitoring plans for the job site which incorporate land, water, air and noise monitoring.

#### 1.4.1.7 Surface and Ground Water

The Contractor shall establish methods of protecting surface and ground water during construction activities.

#### 1.4.1.8 Work Area Plan

The Contractor shall include a work area plan showing the proposed activity in each portion of the area and identifying the areas of limited use or nonuse. The plan shall include measures for marking the limits of use areas.

#### 1.4.1.9 Method of Marking Clearing Limits

The Contractor shall include the method of marking and maintaining markings for limits of clearing.

#### 1.4.1.10 Method of Controlling Equipment

The Contractor shall include a plan of the method for controlling equipment maneuvering to avoid environmental damage.

#### 1.4.1.11 Training of Contractor's Personnel

The Contractor shall include a plan for training and control of his personnel for environmental damage.

#### 1.4.1.12 Prevention and Control of Spillage

The Contractor shall include a plan for prevention and control of damaging spillages.

#### 1.4.1.13 Layout of Work Areas and Other Areas

The Contractor shall include a plan of his method for layout of work areas, plant sites, and waste areas.

#### 1.4.1.14 Method and Location of Waste and Debris Disposal

The Contractor shall include the location for disposal of waste and debris.

#### 1.4.1.15 Preplanning

Meetings of the Contractor with Contracting Officer or his authorized representative as specified in the paragraph MEETINGS, for the purpose of preplanning prevention of environmental damage.

#### 1.4.1.16 Proposed Schedule for Training of Contractor Personnel

The Contractor shall include a schedule of proposed meetings to be attended by all Contractor personnel for the purpose of training for environmental protection with a Contracting Officer's representative present at appropriate intervals. Sufficient length of time to accomplish the purpose shall be included.

#### 1.4.1.17 Method of Training

The Contractor shall include a proposed method of training all new employees in environmental protection before they commence working project.

### 1.5 STORM WATER POLLUTION PREVENTION PLANS

The Contractor shall prepare a storm water pollution prevention plan (PPP) for the construction activity. This plan shall be in accordance with EPAPUB NPDES General Permits for Storm Water Discharges from Construction Sites. The plan shall identify potential sources of pollution resulting from storm water discharge from the project site(s) and present methods for reducing or eliminating such discharge.

The Contracting Officer and the Contractor shall review the PPP to determine the accuracy of the plan. The PPP may be modified to insure that all current measures to prevent offsite migration of pollutants, including soils, are included in the plan.

#### 1.5.1 Contents of the Pollution Prevention Plan

The pollution prevention plan shall include as a minimum:

- (a) a narrative description of potential pollution sources for each construction site through a description of the nature of the construction activity;
- (b) the intended phasing of construction activities related to soil disturbance and the storm water control measure proposed for that activity. For each storm water control measure proposed, the PPP shall indicate when the measure will be implemented. Perimeter controls shall be actively maintained until final stabilization of that portion of the site upward of the perimeter control is established;
- (c) estimates of total acreage to be disturbed, estimates of the runoff coefficient of the site once construction is completed, and any existing soils data or discharge quality data;
- (d) site mapping detailing drainage patterns, slopes, major activities, location of structural controls such as hay bale barriers and the location of point sources;
- (e) storm water management controls appropriate for the project, including perimeter controls, and stabilization practices to be employed such as temporary grading to control runoff velocities, temporary seeding and mulching and permanent seeding and planting. For a common drainage location that serves an area of 2.02 or more disturbed hectares at one time, a sediment basin providing 102 cubic meters of storage per acre drained shall be provided. Equivalent

control measures may be taken where attainable and after approval by the Contracting Officer;

(f) a description of maintenance procedures to be employed to minimize the offsite discharge of pollutants, and an inspection program to insure that the PPP is effective, or if not, to insure that necessary changes to the plan are made and implemented in a timely manner;

(g) identification for each storm water management measure set forth in the plan, the Contractor and/or subcontractor(s) that will implement such measure. Contractor and subcontractors identified in the PPP shall sign a certification that they have reviewed the general permit as listed in the paragraph STORM WATER POLLUTION PREVENTION PLANS and understand the terms and conditions therein. All such certifications shall be included in the PPP, which is to be kept on the job side for inspection by EPA or state or local regulatory agencies;

(h) plan for control of offsite vehicle tracking of soils. Contractor shall make every effort to keep soils onsite. This may be accomplished by including paved or graveled entrances, graveled and dedicated roadways, or vehicle wash stations.

#### 1.6 MEETINGS

The Contractor shall meet with representatives of the Contracting Officer to develop mutual understanding relative to compliance with this section of the specifications and administration of the environment protection program. The Contractor shall be prepared to discuss the program in conferences convened by the Contracting Officer before starting work on each major phase of operation. Approval of the Contractor's plan for environmental protection will not relieve the Contractor of his responsibility for adequate and continuing control of pollutants and protection of environmental features. All Contractor personnel shall be required to attend.

#### 1.7 SUBCONTRACTORS

Assurance of compliance with this section by subcontractors will be the responsibility of the Contractor.

#### 1.8 REGULATORY REQUIREMENTS

The Contractor shall comply with all federal, state, and local regulatory and statutory requirements.

#### 2 PRODUCTS (NOT APPLICABLE)

#### 3 EXECUTION

##### 3.1 PROTECTION OF ENVIRONMENTAL RESOURCES

The environmental resources within the project boundaries and those affected outside the limits of permanent work under this contract shall be protected during the entire period of this contract. The Contractor shall confine his activities to areas defined by the contract drawings or specifications. Environmental protection shall be as stated in the following subparagraphs.

### 3.1.1 Protection of Land Resources

Prior to the beginning of any construction, the Contracting Officer will identify all land resources to be preserved within the Contractor's work area. The Contractor shall not remove, cut, deface, injure, or destroy land resources including trees, shrubs, vines, grasses, topsoil, and land forms without special permission from the Contracting Officer. No ropes, cables, or guys shall be fastened to or attached to any trees for anchorage unless specifically authorized. Where such special emergency use is permitted, the Contractor shall provide effective protection for land and vegetation resources at all times as defined in the following subparagraphs.

#### 3.1.1.1 Work Area Limits

Prior to any construction, the Contractor shall mark the areas where no work is to be performed under this contract. Isolated areas within the general work area which are to be saved and protected shall also be marked or fenced. Monuments and markers shall be protected before construction operations commence and during all construction operations. Where construction operations are to be conducted during darkness, the markers shall be visible during darkness. The Contractor shall convey to his personnel the purpose of marking and/or protection of all necessary objects.

#### 3.1.1.2 Protection of Landscape

Trees, shrubs, vines, grasses, land forms and other landscape features to be preserved, indicated and defined on the drawings submitted by the Contractor as a part of the Environmental Protection Plan, shall be clearly identified by marking, fencing, or wrapping with boards, or any other approved techniques.

#### 3.1.1.3 Reduction of Exposure of Unprotected Erodible Soils

Earthwork brought to final grade shall be finished as indicated and specified. Side slopes and back slopes shall be protected as soon as practicable upon completion of rough grading. All earthwork shall be planned and conducted to minimize the duration of exposure of unprotected soils. Except in instances where the constructed feature obscures borrow areas, quarries and waste material areas, these areas shall not initially be cleared in total. Clearing of such areas shall progress in reasonably sized increments as needed to use the areas developed as approved by the Contracting Officer.

#### 3.1.1.4 Temporary Protection of Disturbed Areas

Such methods as necessary shall be utilized to effectively prevent erosion and control sedimentation, including but not limited to the following:

##### a. Retardation and Control of Runoff

Runoff from the construction site shall be controlled by construction of diversion ditches, benches, and berms to retard and divert runoff to protected drainage courses, and the Contractor shall also utilize any measures required by area-wide plans approved under Paragraph 208 of the Clean Water Act.

#### 3.1.1.5 Erosion and Sedimentation Control Devices.

The Contractor shall construct or install all temporary and permanent erosion sedimentation control features. Temporary erosion and sediment control measures shall be maintained until permanent drainage and erosion control facilities are completed and operative.

#### 3.1.1.6 Stabilization of Disturbed Soils

Stabilization measures of areas involved in the Pollution Prevention Plans shall be initiated on disturbed areas as soon as practicable, but no more than 14 days after the construction activity on a particular portion of the site has temporarily or permanently ceased except as follows:

(a) where construction activities will resume on a portion of the site within 21 days from the time when construction activities temporarily ceased;

(b) where the initiation of the stabilization measure is precluded by snow cover in which case stabilization measures shall be initiated as soon thereafter as practicable.

#### 3.1.1.7 Inspections

Weekly inspections of construction sites shall be conducted by the Contractor to insure that the various controls and components of the various plans required by this section are in place. In addition, the Contractor shall make an inspection within 24 hours following a 12 mm or greater rainfall event to insure that the controls are working adequately and have not been impacted by the rainfall event.

#### 3.1.1.8 Location of Contractor Facilities

The Contractor's field offices, staging areas, stockpiles, storage, and temporary buildings shall be placed in areas designated on the contract drawings and approved by the Contracting Officer. Temporary movement or relocation of Contractor facilities shall be made only on approval by the Contracting Officer.

#### 3.1.1.9 Temporary Excavation and Embankments

Temporary excavation shall be controlled to protect adjacent areas from contamination.

#### 3.1.1.10 Disposal of Solid Wastes

Solid wastes (excluding clearing debris) shall be placed in containers which are emptied on a regular schedule. All handling and disposal shall be conducted to prevent contamination. The Contractor shall transport all solid waste off Government property and dispose of it in compliance with Federal, State, and local requirements for solid waste disposal.

#### 3.1.1.11 Disposal of Chemical Wastes

Chemical wastes shall be stored in corrosion resistant containers, removed from the work area and disposed of in accordance with Federal, State, and local regulations.



#### 3.1.1.12 Disposal of Discarded Materials

Discarded materials other than those which can be included in the solid waste category shall be handled as directed by the Contracting Officer.

#### 3.1.1.13 Disposal of Materials at Ft. Sill

Disposal of trash, garbage, or domestic waste shall be in the Ft. Sill Post Sanitary Landfill. Demolition rubble shall be disposed of in the Ft. Sill rubble pit. Disposal of metals shall be the responsibility of the Contractor off Government Property. Disposal of Contractor produced POL products, chemicals, or other hazardous or toxic compounds shall be in accordance with Ft. Sill Regulation USAFACFS Regulation 200-2. The Contracting Officer shall be advised of the type of Contractor produced POL products, chemicals, or other hazardous or toxic compounds and the amount of these products. The Contracting Officer will determine the methods of disposal of these products and such actions may require EPA or State permits.

### 3.2 HISTORICAL, ARCHAEOLOGICAL AND CULTURAL RESOURCES

Existing historical, archaeological and cultural resources within the Contractor's work area will be so designated by the Contracting Officer and precautions shall be taken by the Contractor to preserve all such resources as they existed at the time they were pointed out to the Contractor. The Contractor shall install all protective devices such as off-limit markings, fencing, barricades, or other devices deemed necessary by the Contracting Officer for these resources so designated on the contract drawings and shall be responsible for their preservation during this contract. If during construction items of apparent archaeological or historical interest are discovered, they shall be left undisturbed and the Contractor shall report the find immediately to the Contracting Officer.

### 3.3 PROTECTION OF WATER RESOURCES

The Contractor shall keep construction activities under surveillance, management and control to avoid pollution of surface and ground waters. Special management techniques as set out below shall be implemented to control water pollution by the listed construction activities which are included in this contract.

#### 3.3.1 Monitoring of Water Areas Affected by Construction Activities

Monitoring of water areas affected by construction activities shall be the responsibility of the Contractor. All water areas affected by construction activities shall be monitored by the Contractor.

### 3.4 PROTECTION OF AIR RESOURCES

The Contractor shall keep construction activities under surveillance, management and control to minimize pollution of air resources. All activities, equipment, processes, and work operated or performed by the Contractor in accomplishing the specified construction shall be in strict accordance with all Federal and State of Oklahoma emission and performance laws and standards. Special management techniques as set out below shall be

implemented to control air pollution by the construction activities which are included in the contract.

#### 3.4.1 Particulates

Dust particles, aerosols, and gaseous by-products from all construction activities, processing and preparation of materials, such as from asphaltic batch plants, shall be controlled at all times, including weekends, holidays and hours when work is not in progress. The Contractor shall maintain all excavations, stockpiles, haul roads, permanent and temporary access roads, plant sites, spoil areas, borrow areas, and all other work areas within or outside the project boundaries free from particulates which would cause the air pollution standards mentioned in the paragraph "PROTECTION OF AIR RESOURCES" to be exceeded or which would cause a hazard or a nuisance. Sprinkling, chemical treatment of an approved type, light bituminous treatment, or other methods will be permitted to control particulates in the work area. Sprinkling, to be efficient, must be repeated at such intervals as to keep the disturbed area damp at all times. The Contractor must have sufficient competent equipment available to accomplish this task. Particulate control shall be performed as the work proceeds and whenever a particulate nuisance or hazard occurs.

#### 3.4.2 Hydrocarbons and Carbon Monoxide

Hydrocarbons and carbon monoxide emissions from equipment shall be controlled to Federal and State allowable limits at all times.

#### 3.4.3 Odors

Odors shall be controlled at all times for all construction activities, processing and preparation of materials.

#### 3.4.4 Monitoring Air Quality

Monitoring of air quality shall be the responsibility of the Contractor. All air areas affected by the construction activities shall be monitored by the Contractor.

### 3.5 TESTS

The Contractor shall establish and maintain quality control for environmental protection operations to assure compliance with contract requirements and maintain records of his quality control for all construction operations, including, but not limited to the following items. The Contractor shall record on daily reports any problems in complying with laws, regulations and ordinances and corrective action taken. Three copies of these records and tests, as well as the records of corrective action taken, shall be furnished the Government as directed by the Contracting Officer.

#### 3.5.1 Laws, Regulations and Ordinances

The Contractor must comply with all Federal, State, and local laws, regulations and ordinances concerning pollution control.

### 3.5.2 Protection of Land Resources

The Contractor shall prevent landscape defacement and provide post-construction clean-up.

### 3.5.3 Protection of Water Resources

The Contractor shall prevent the contamination of lakes, ditches, or other bodies of water with harmful chemicals; the Contractor shall dispose of waste materials; and the Contractor shall provide erosion control.

### 3.5.4 Pollution Control Facilities

The Contractor shall provide for the maintenance of pollution control facilities. The Contractor shall conduct a training course on the maintenance of pollution control facilities.

## 3.6 INSPECTION

The Contracting Officer will notify the Contractor in writing of any observed noncompliance with any of the Contractor's required plans. The Contractor shall, after receipt of such notice, inform the Contracting Officer of proposed corrective action and take such action as may be approved. If the Contractor fails to comply promptly, the Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No time extensions will be granted or costs or damages allowed to the Contractor for any such suspension.

## 3.7 POST CONSTRUCTION CLEANUP

The Contractor shall clean up all areas used for construction.

## 3.8 RESTORATION OF LANDSCAPE DAMAGE

The Contractor shall restore all landscape features damaged or destroyed during construction operations outside the limits of the approved work areas. Such restoration shall be in accordance with the plans submitted for approval by the Contracting Officer.

## 3.9 MAINTENANCE OF POLLUTION FACILITIES

The Contractor shall maintain all constructed facilities and temporary pollution control devices for the duration of the contract or for that length of time construction activities create the particular pollutant.

## 3.10 TRAINING OF CONTRACTOR PERSONNEL IN POLLUTION CONTROL

The Contractor shall train his personnel in all phases of environmental protection. The training shall include methods of detecting and avoiding pollution, familiarization with pollution standards, both statutory and contractual, and installation and care of facilities (vegetative covers and instruments required for monitoring purposes) to insure adequate and continuous environmental pollution control.

### 3.11 RECORD KEEPING

During construction, all records shall be retained onsite. Inspection reports, and modifications of the plans required shall be retained for 3 years following construction.

## SECTION 01580

## BULLETIN BOARD, PROJECT SIGN, AND SAFETY SIGN

## 1 GENERAL

## 1.1 GENERAL

Immediately upon beginning of work under this contract, the Contractor shall accomplish the work covered in this section. Locations of the bulletin board, project sign, and safety sign shall be as determined by the Contracting Officer. Upon completion of work under this contract, the signs shall be removed from the jobsite and shall remain the property of the Contractor.

## 2 PRODUCTS

## 2.1 BULLETIN BOARD

Bulletin board shall be a weatherproof, glass-covered board not less than 900 by 1200 mm in size, for displaying the Equal Employment Opportunity Poster, a copy of the wage decision contained in the contract, Wage Rate Information Poster, and other information approved by the Contracting Officer. The bulletin board shall be located at the site of work in a conspicuous place easily accessible to all employees. Legible copies of the above items shall be displayed until work under the contract is complete.

## 2.2 PROJECT SIGN

The project sign shall be constructed as shown on the drawings at the end of this section. The sign shall receive one coat of primer paint followed by two coats of finish gloss exterior enamel paint, color as directed by the Contracting Officer. Lettering shall be as shown on the drawing and shall be white gloss exterior type enamel.

## 2.3 SAFETY SIGN

The safety sign shall be located in a conspicuous place within view of all employees and visitors. Details of construction shall be as shown on the drawing attached at the end of this section. Paint shall be gloss exterior enamel. Lettering shall be as shown on the drawing. The Contractor shall keep the safety sign current by posting the numbers daily.

## 3 EXECUTION (NOT APPLICABLE)

Below are two samples of the construction project identification sign showing how this panel is adaptable for use to identify either military (top), or civil works projects (bottom). The graphic format for this 4' x 6' sign panel follows the legend guidelines and layout as specified below. The large

4' x 4' section of the panel on the right is to be white with black legend. The 2' by 4' section of the sign on the left with the full Corps Signature (reverse version) is to be screen printed Communications Red on the white background.

This sign is to be placed with the Safety Performance Sign shown on the following

page. Mounting and fabrication details are provided on page 16.4.

Special applications or situations not covered in these guidelines should be referred to the District/Division sign coordinator.

Legend Group 1: One- to two-line description of Corps relationship to project.

Color: White

Typeface: 1.25" Helvetica Regular

Maximum line length: 19"

Legend Group 2: Division or District Name (optional). Placed below 10.5" Reverse Signature (6" Castle).

Color: White

Typeface: 1.25" Helvetica Regular

Legend Group 3: One- to three-line project title legend describes the work being done under this contract.

Color: Black

Typeface: 3" Helvetica Bold

Maximum line length: 42"

Legend Group 4: One- to two-line identification of project or facility (civil works) or name of sponsoring department (military).

Color Black

Typeface: 1.5" Helvetica Regular

Maximum line length: 42"

Cross-align the first line of Legend Group 4 with the first line of the Corps Signature (US Army Corps) as shown

Legend Groups 5a-b: One- to five-line identification of prime contractors including: type (architect, general contractor, etc), corporate or firm name, city, state. Use of Legend Group 5 is optional.


Color: Black


Typeface: 1.25" Helvetica Regular

Maximum line length: 21"

All typography is flush left and rag right, upper and lower case with initial capitals only as shown.

Letter- and word-spacing to follow Corps standards as specified in Appendix D.

3"	3"	42"	3"	
4.5"	 <p><b>US Army Corps of Engineers</b> Norfolk District</p>	<h2>Feedwater Pumps and Piping for Building 1985</h2> <p>Fort Eustis, Virginia</p> <p>Architects: Williams-Russell &amp; Associates Atlanta, Georgia</p> <p>Contractor: Fenwick Associates, Inc. Athens, Georgia</p>	6"	
2"			4.5"	
6.25"			4.5"	
10.5"			6"	
2.5"			2.25"	
			9.5"	
			1.875"	
			1.87"	
			1.87"	
			1.87"	
			7.75"	
3"	21"	1"	21"	2"

<p>Design and Construction Supervised by:</p>  <p><b>US Army Corps of Engineers</b> Norfolk District</p>	<h2>Expansion of Fish Hatchery</h2> <p>Bonneville Lock and Dam</p> <p>Contractor: Will Construction Co. Portland, Oregon</p> <p>Consulting Engineer: International Engineering Company, Inc. Dallas, Texas</p>
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Each contractor's safety record is to be posted on Corps managed or supervised construction projects and mounted with the construction project identification sign.

The graphic format, color, size and type-faces used on the sign are to be reproduced exactly as specified below. The title with First Aid logo in the top section of the sign and the performance record captions are

standard for all signs of the type. Legend Groups 2 and 3 below identify the project and the contractor and are to be placed on the sign as shown.

Safety record numbers are mounted on individual metal plates and are screw-mounted to the background to allow for daily revisions to posted safety performance record.

Legend Group 1: Standard two-line title "Safety is a Job requirement" with (8 od.) Safety Green First Aid logo.  
Color: to match PMS 347  
Typeface: 3" Helvetica Bold  
Color: Black

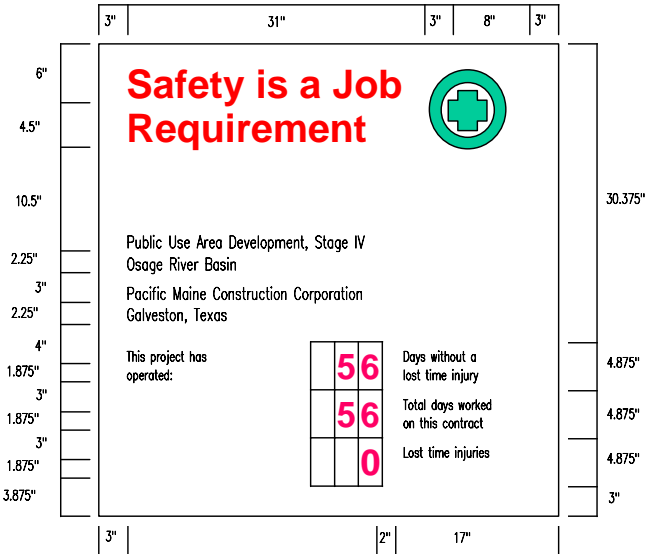
Legend Group 2: One to two-line project title legend describes the work being done under this contract and name of host project.  
Color: Black  
Typeface: 1.5" Helvetica Regular  
Maximum line length: 42"

Legend Group 3: One to two-line identification: name of prime contractor and city, state address.  
Color: Black  
Typeface: 1.5" Helvetica Regular  
Maximum line length: 42"

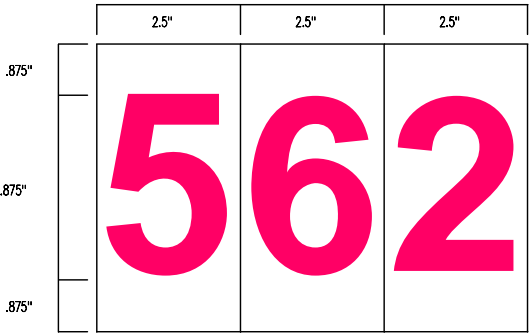
Legend Group 4: Standard safety record captions as shown.  
Color: Black  
Typeface: 12.5" Helvetica Regular

Replaceable numbers are to be mounted on white .060 aluminum plates and screw-mounted to background.  
Color: Black  
Typeface: 3" Helvetica Regular  
Plate size: 2.5" x .5"

All typography is flush left and rag right. Upper and lower case with initial capitals only as shown. Letter- and word-spacing to follow Corps standards.



Sign Type	Legend Size	Panel Size	Post Size	Specification Code	Mounting Height	Color Bkg/Lgd
CID-02	various	4"x4"	4"x4"	HDO-3	48"	WH/BK-GR



SAFETY PERFORMANCE SIGN

Fig. 5d

All Construction Project Identification signs and Safety Performance signs are to be fabricated and installed as described below. The signs are to be erected at a location designated by the contracting officer and shall conform to size, format, and typographic standards.

The sign panels are to be fabricated from .75" High Density Overlay Plywood.

Sign graphics to be prepared on a white non-reflective vinyl film with positionable adhesive backing.

All graphics except for the Communications Red background with Corps signature on the project sign are to die-cut or computer cut nonreflective vinyl, pre-spaced legends prepared in the sizes and typefaces specified and applied to the background panel following the graphic formats shown.

The 2' x 4' Communications Red panel (to match PMS-032) with full Corps signature (reverse version) is to be screen printed on the white background identification of the District / Division may be applied under the signature with white cut vinyl letters prepared to Corps standards

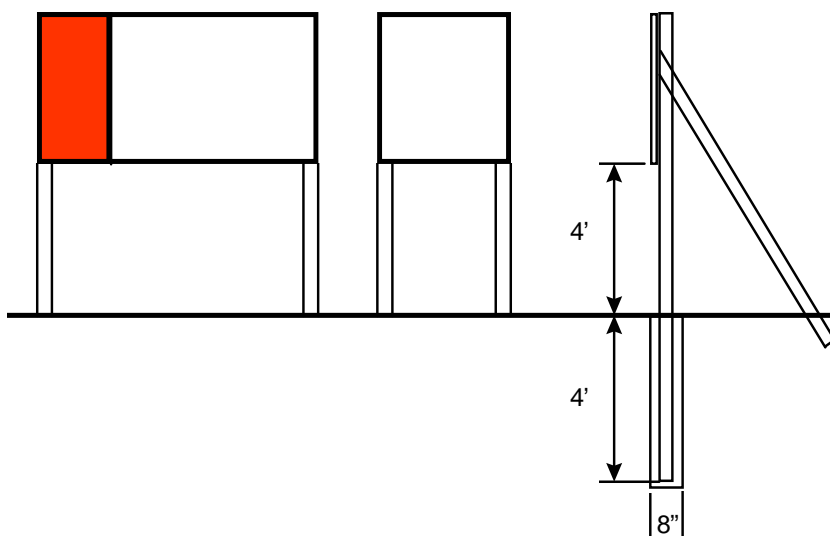
Drill and insert six (6) .375 T-nuts from the front face of the HDO sign panel. Position holes as shown. Flange of T-nut to be flush with sign face

Apply Graphic panel to prepared HDO plywood panel following manufactures instructions

Sign uprights to be structural grade 4" x 4" treated Douglas Fur or Southern Yellow Pine. No 1 or better. Post to be 12' long Drill six (6) .375" mounting holes in uprights to align with T-nuts in sign panel. Countersink (5") back of hole to accept socket head cap screw ( 4" x .375" ).

Assemble sign panel and uprights. Imbed assembled sign panel and uprights in 4' hole. Local soil conditions and/or wind loading may require bolting additional 2" x 4" struts on inside face of uprights to reinforce installation shown.

Shown below the mounting diagram is a panel layout grid with spaces provided for project information. Photocopy this page and use as a worksheet when preparing sign Legend orders.



#### Construction Project Sign Legend Group 1

1 \_\_\_\_\_

2 \_\_\_\_\_

#### Legend Group 2 Division/District Names

1 \_\_\_\_\_

2 \_\_\_\_\_

#### Legend Group 3 Project Title

1 \_\_\_\_\_

2 \_\_\_\_\_

3 \_\_\_\_\_

#### Legend Group 4 Facility Name

1 \_\_\_\_\_

2 \_\_\_\_\_

#### Legend Group 5a: Contractor/A&E

1 \_\_\_\_\_

2 \_\_\_\_\_

3 \_\_\_\_\_

4 \_\_\_\_\_

5 \_\_\_\_\_

#### Legend Group 5b: Contractor/A&E

1 \_\_\_\_\_

2 \_\_\_\_\_

3 \_\_\_\_\_

4 \_\_\_\_\_

5 \_\_\_\_\_

#### Safety Performance Sign Legend Group 1: Project Title

1 \_\_\_\_\_

2 \_\_\_\_\_

#### Legend Group 2: Contractor/A&E

1 \_\_\_\_\_

2 \_\_\_\_\_



## SECTION 01600

## MATERIAL AND EQUIPMENT

## 1 GENERAL

## 1.1 INVENTORY OF INSTALLED PROPERTY

A list shall be made of equipment or units of equipment that require electrical power, water, or fuel, or that may require periodic or eventual removal or replacement. Such items shall include, but not limited to, air handling units; fans; air conditioners; compressors; condensers; boilers; thermal exchangers; pumps; cooling towers; tanks; fire hydrants; large plumbing fixtures such as sinks water closets, lavatories, urinals, and showers; fire suppression systems (sprinkler heads by type, etc.); and light fixtures. The list shall be kept up to date as items are installed or claimed for payment as material on hand. The list will be reviewed periodically by the Government to ensure completeness and accuracy. Partial payment may be withheld for equipment not incorporated in the list at the discretion of the Contracting Officer. The list shall include on each item as applicable: description, manufacturer, model or catalog No., serial No., input (power, voltage, BTU, tons, etc.), size or capacity (e.g. tanks), installation location, net inventory costs; any other data necessary to describe item. Final list shall be turned over to the Contracting Officer 60 days prior to prefinal inspection.

## 1.2 SCRAP MATERIAL

Materials specified to be removed and become the property of the contractor are designated as scrap, and the bidder should make due allowance in his bid for the value, if any, of such scrap.

## 2 PRODUCTS (NOT APPLICABLE)

## 3 EXECUTION (NOT APPLICABLE)

## SECTION 01700

## CONTRACT CLOSEOUT

## 1 GENERAL

## 1.1 WARRANTY OF CONSTRUCTION (APR 1984)

## 1.1.1 General

See Paragraph "Warranty of Construction" in Section 00800 - SPECIAL CONTRACT REQUIREMENTS

## 1.2 PREWARRANTY CONFERENCE

Prior to contract completion and at a time designated by the Contracting Officer or his representative, the Contractor shall meet with the Contracting Officer to develop a mutual understanding with respect to the requirements of Paragraph: WARRANTY OF CONSTRUCTION. The Contracting Officer shall establish communication procedures for Contractor notification of warranty defects, priorities with respect to the type of defect and reasonable time required for Contractor response, and other details deemed necessary by the Contracting Officer for the execution of the construction warranty.

## 1.3 AS-BUILT DRAWINGS

## 1.3.1 General

The Contractor shall be responsible to prepare and maintain the as-built drawings for this project. "As-built" drawings are a specific and distinct deliverable item under the terms of the contract. Failure to maintain and deliver these drawings will be treated by the Government in a manner similar to the failure to provide a specified item of construction material or equipment.

## 1.3.2 As-Built Drawing Components

There shall be three (3) components to the as-built drawings:

- a. Working as-built drawings;
- b. Final as-built drawings (dimensionally stable mylar film);
- c. Digital as-built drawings (digital files saved to approved media).

## 1.3.3 Scope of As-Built Drawings.

The as-built drawings shall be a record of the construction as installed and completed by the Contractor. They shall include the information shown on the contract set of drawings and a record of deviations, modifications, or changes from those drawings, however minor, which were incorporated into the work, additional work not appearing on the contract drawings, and changes which are made after final inspection of the work. Level of detail provided on as-built drawings shall match that of the original contract drawings. If additional work changes the as-built conditions after submission of the as-built drawings, the Contractor shall furnish revised or additional drawings to depict as-built conditions. Critical shop drawings or other submittal items, which exceed the level of detail of the as-built drawings and which are needed for the proper operation and maintenance of the project, shall be provided in Operations and Maintenance Manuals.

#### 1.3.4 Working As-Built Drawings

The Contractor shall maintain two sets of paper prints which shall show the as-built conditions and which shall be kept current and available on the jobsite at all times. One set shall be maintained in the Contractor's on-site office, and the second set will be maintained in the Corps of Engineers' Resident Office. Changes from the contract plans which are made in the work or additional information uncovered in the course of construction shall be accurately and neatly recorded as they occur by means of details and notes. The as-built marked prints shall be jointly inspected for accuracy and completeness by the Contracting Officer and the Contractor prior to submission of each monthly pay estimate. A representative of the Contractor and a representative of the government shall each sign and date the coversheet of the record drawings when reviewed. Failure to submit the working as-builts for review may be considered as an incomplete pay estimate. The drawings shall show the following information, but not be limited thereto:

- a. The location and description of utility lines or other installations of any kind or description known to exist within the construction area. Exterior utilities shall be located in both the horizontal and vertical planes. Dimensions shall be within an accuracy of approximately 100mm or 4 inches. Vertical location shall be referenced to finished grade or floor level and the horizontal location referenced to a permanent structure such as the face of a building or street curb.
- b. The location and dimensions of changes within the building or structure. Accuracy of dimensions will match the level of accuracy of the original contract drawings. Items depicted symbolically shall use the same symbology of the original drawings. Items depicted on the original drawings without dimensions shall be shown in their approximate actual "as-constructed" location.
- c. Correct grade or alignment of roads, structures, or utilities if changes were made from contract plans.
- d. Correct elevations if changes were made in site grading.
- e. Changes in details of design or additional information obtained from shop drawings prepared or furnished by the Contractor. Information incorporated into as-built drawings shall be at a level of detail consistent with the original drawings.
- f. The topography and grades of drainage constructed or affected as a part of the construction.
- g. Changes or modifications resulting from the final inspection.
- h. Where contract drawings or specifications allow options, the option selected for construction shall be shown on the as-built drawings.
- i. Working as-built drawings of each drawing shall have the words "DRAWING OF WORK AS-BUILT" in letters at least 3/16-inch high placed below the title block between the border and the trim line. The date of completion and the words "REVISED AS-BUILT" shall be placed in the revision block above the latest existing revision notation.
- j. The title block for additional as-built drawings shall be similar to that used on the original drawings.

### 1.3.5 Final Working As-Built Prints for Review and Approval

Two copies of the working as-built marked prints shall be delivered to the Contracting Officer at the time of final inspection for his review and approval. Upon approval, one copy of the as-built marked prints will be returned to the Contractor. If upon review, the drawings are found to contain errors or omissions, they will be returned to the Contractor for corrections. The Contractor will complete the corrections and return the drawings to the Contracting Officer within 10 calendar days.

### 1.3.6 Final Drawings (CAD)

The original drawings have been prepared by Computer Aided Drafting (CAD). These digital files will be provided to the Contractor upon request. Upon approval of the working as-built prints, the Contractor shall modify the original CAD drawing files to bring them into agreement with the working as-built prints. If additional drawings are required, they shall be prepared in the MicroStation format. The Contractor shall submit final as-built CAD drawings in MicroStation Version 5.0.95 or later format.

#### 1.3.6.1 Media

Digital Data Format shall be as listed below in order of preference.

1. 5-1/4" Read/Write (R/W) Compact Disc (CD) (650, IBM compatible format) (non-compressed).
2. Bernoulli Removable Hard Disk utilizing native file format (non-compressed)(40mb or larger, IBM compatible format)
3. 3.5-in. High-density diskettes(1.44mb) utilizing Windows Backup or Pkzip software.

#### 1.3.6.2 Draftsmanship

Only personnel proficient in the preparation of digital engineering drawings to standards satisfactory and acceptable to the Government shall be employed to modify the original contract drawings or prepare additional new drawings. All additions and corrections shall be neat, clean, and legible and shall match the adjacent existing linework and lettering being annotated in type, density, size, and style. The Contracting Officer will review all as-built drawings for accuracy and conformance to the above specified drafting standards. The Contractor shall make all corrections, changes, additions, and deletions required to meet these standards.

a. Final as-built revisions of each drawing shall have the words "DRAWING OF WORK AS-BUILT" in letters at least 3/16 inch 7 mm high placed below the title block between the border and the trim line. The date of completion and the words "REVISED AS-BUILT" shall be placed in the revision block above the latest existing revision notation. All marking highlighting previous revisions shall be removed.

b. The title block for additional as-built drawings shall be similar to that used on the original drawings.

### 1.3.7 Final Submittal

Not later than 60 days after the contract completion date, the Contractor shall submit to the Contracting Officer two sets of final as-built drawings on acceptable media as described in paragraph MEDIA above together with one

set of approved working as-built marked-up prints, one set of as-built reproducible drawings (mylar), and one set of blue line prints, which will become the property of the Government upon final approval. Format for final as-built drawings shall be as specified in the paragraph FINAL DRAWINGS (CAD) above. Approval and acceptance of final as-built drawings shall be accomplished before final payment is made to the Contractor.

#### 1.4 OPERATING AND MAINTENANCE INSTRUCTIONS

##### 1.4.1 General

Operating and maintenance (O&M) instructions shall be furnished for equipment and systems as required in the SPECIFICATIONS. The operating and maintenance instructions shall include two separate manuals, an Operations Manual and a Maintenance Manual, and shall include framed instructions when required by the specific section. Each system or piece of equipment shall be covered in the two separate manuals regardless of the number of suppliers or subcontractors involved. Combining more than one system or piece of equipment into the same manuals may be permitted if the manuals are indexed by section and do not exceed 4 inches 100 mm in thickness. Data submitted for the manual shall be in addition to that furnished as shop drawings. Unless otherwise specified in the SPECIFICATIONS, the Contractor shall assemble six complete bound Operations Manuals and six complete bound Maintenance Manuals. Operations and maintenance data shall be submitted within 30 days after approval of the equipment or system and not less than 60 days prior to scheduled testing. Operations and maintenance data shall also be submitted and approved by the time the project reaches 90 percent completion. If O & M data cannot be completed until equipment or systems have been tested and balanced, a draft copy shall be submitted within the specified time. The completed O&M data shall then be submitted within 30 days after the completion of such testing and balancing.

Unless otherwise authorized by the Contracting Officer, the Government will not accept the equipment or systems nor will the Government take possession of the associated work until O & M data are submitted and approved.

##### 1.4.2 Manuals

Operations and maintenance manuals shall be assembled in a durable stiff (hard) covered binder for 8-1/2 by 11-inch 213 by 275 mm sheets with slide binding or screwpost fastening for replacement. Loose-leaf ring binders shall not be used. A permanently printed title on the covers shall show the project name, contract number, and the name of the equipment or system. Shop assembly or special drawings for manuals or parts catalogs shall be of a size that requires folding only a left-to-right coordinate. Each sheet shall be numbered and an index shall be provided. All standard catalog cuts, manufacture's data, parts sheets, or illustrations, shall be originals. A warning page shall be provided to warn of potential dangers, such as high voltage, toxic chemicals, flammable liquids, explosive materials, carcinogens, or high pressures. The warning page shall be placed inside the front cover or tab page if more than one section is combined, in front of the title page. The title page shall show the name of the preparing firm (designer or contractor) and the date of publication. All non-applicable data such as descriptions of other models and optional equipment not included shall be marked out or all applicable data shall be distinctly highlighted. If reference is made to other drawings or data, they shall be included. Manuals shall include the following information for each item of equipment or system:

#### 1.4.2.1.1 Operations Manual

The Operations Manual shall show operating procedures, sequences, and precautions. The Contractor shall coordinate subcontractors, suppliers, and manufacturers to assure complete submittals on interrelated components. Include adequate illustrative material to identify and locate operating controls, indicating devices and locations of areas or items requiring operation or adjustments. As a minimum, the manual shall include piping and equipment layout and simplified wiring and control diagrams of the complete system as installed. Describe, in detail, starting and stopping procedures for components, adjustments required to obtain optimum equipment performance, and corrective actions for malfunctions. Catalog cuts describing equipment operating procedures shall not be used as system operating instructions.

#### 1.4.2.2 Maintenance Manual

The Maintenance manual shall provide instructions for routine and preventive maintenance showing lubrication, dismantling, assembly, repair, and adjustment, electric schematic and connection diagrams, hydraulic circuit diagrams with control and relief valve settings, control and interlock system diagrams, and lists of special tools required. Lubrication instructions shall be for service intended and shall include tables indicating items, frequencies, grades, and types of lubricants. Instructions shall include clearances, bolt torques, pressure settings, and other data. The nature and frequency of routine maintenance and procedures shall be indicated. The materials and test equipment that may be required shall be noted. Performance sheets and graphs, as applicable, showing capacity data, efficiencies, electrical characteristics, pressure drops, and flow rates shall be included. Marked-up catalogs or catalog pages shall not be used for this purpose. Performance information shall be presented concisely and shall contain only data pertaining to equipment actually installed.

Spare parts data and catalogs showing identification, nomenclature, part numbers, required parts, recommended spare parts stocked, and spare parts supplied shall be included. Local source of parts and dated current price list shall be included. Data shall match equipment furnished. Standard catalog data may be used only if irrelevant parts are marked out or relevant parts are clearly identified. Repair information shall show diagrams and schematics, guidance for diagnosing problems, and detailed instructions for making repairs. Troubleshooting information shall be provided that includes a statement of the indication or symptom of trouble and the sequential instructions necessary. Test hookups to determine the cause of trouble, special tools and test equipment, and methods for returning the equipment to operating conditions shall be identified. Information may be in chart form or in tabular format with appropriate headings.

#### 1.4.3 Framed Instructions

Framed instructions shall include as-built schematics of all wiring, controls, piping, etc., necessary for the operation of the equipment or system, and condensed, printed description of the system and of the operating procedure. The framed data may include approved shop drawings, layout drawings, riser and block diagrams and shall indicate all necessary interrelationships with other equipment and systems. The operating instructions shall explain equipment or system prestart checkout, start-up and shut-down procedures, safety precautions, preventive maintenance procedures, and normal operations checks for satisfactory performance of the

equipment or system. The framed data may be presented in one or several frames, under glass or plexiglas, for clarity and convenience of location. The framed data presentation and outline shall be acceptable to the Contracting Officer and posted at locations designated by the Contracting Officer. The data shall be posted before personnel training or performance testing acceptance for the related items of equipment or system.

#### 1.5 TRAINING

Formal classroom and on-site training shall be provided as required in other sections of these Specifications. If significant changes or modifications in the equipment or systems are made during the term of the contract after instructions have been concluded, additional instructions shall be provided to acquaint the O&M personnel with the changes or modifications.

The Contractor shall videotape all formal classroom and on-site instruction training sessions. The Contractor shall provide equipment, material and trained personnel to record the sessions using VHS audio-video recording format. Upon completion of the training instructions, the recordings shall become the property of the Government. The recordings shall be identified, indexed, and placed in appropriate approved storage containers for submittal to the Contracting Officer."

#### 1.6 PAYMENT VALUES FOR O&M MANUALS AND AS-BUILT DRAWINGS (SWD LTR 8/2/90 & MEMO ES-Q DTD 1 JUN 94)

##### 1.6.1 O & M Manuals

The estimated value for O&M manuals is considered by the Government to be \$100,000. Payments will be made for this work only upon receipt and approval of O&M data as required in paragraphs "Operating and Maintenance Instructions" and "Training" above. Payment in the amount of 50 percent of the estimated value may be made upon receipt and approval of the draft O&M data as specified in paragraph "Operating and Maintenance Instructions," provided all other submittals have been submitted and approved.

##### 1.6.2 As-Built Drawings

The estimated value of as-built drawings is considered by the Government to be \$25,000. Payments will be made for this work only upon receipt and approval of final as-built drawings as required in paragraph "As-Built Drawings" above.

#### 1.7 YEAR 2000 (Y2K) INFORMATION TECHNOLOGY COMPLIANCE

##### 1.7.1 Written Certification

Submit written certification that Work has been inspected, and that Work of this project is in accordance with the following:

- a. Information technology (equipment, hardware or software, embedded or otherwise) that processes date/time calculations supplied or installed by the Contractor as part of this contract shall be Year 2000 (Y2K) compliant. Embedded systems could include heating ventilating systems, security systems, elevator controls, utility monitoring and control systems, etc. Y2K compliant, as used in this contract, means with respect to information technology, that the information accurately processes date/time data (including, but not limited to, calculating, comparing, and sequencing) from, into, and between the twentieth and twenty-first centuries and the years 1999 and 2000 and leap year

calculations, to the extent that other information technology, used in combination with the information technology being acquired, properly exchanges date/time data with it. Information technology shall operate continually without any performance degradation due to Y2K compliance issues.

#### 1.7.2 Non-Compliant Equipment

The Contractor is responsible for replacing any Y2K non-compliant equipment, hardware, software, embedded or otherwise at no cost to the Owner Government. The Contractor will also be responsible for all costs or damages incurred by the Owner Government as a result of the Contractor providing any Y2K non-compliant equipment, hardware, software, embedded or otherwise.

2 PRODUCTS (NOT APPLICABLE)

3 EXECUTION (NOT APPLICABLE)

--End of Section--



## SECTION 02215

## GEOTEXTILES

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designations only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) STANDARDS:

ASTM C 33	(1997) Standard Specification for Concrete Aggregates
ASTM D 4354	(1989; R-1994) Standard Practice for Sampling of Geosynthetics for Testing
ASTM D 4355	(1992) Standard Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus)
ASTM D 4533	(1991) Standard Test Method for Trapezoid Tearing Strength of Geotextiles
ASTM D 4632	(1991) Standard Test Method for Grab Break Load and Elongation of Geotextiles
ASTM D 4751	(1993) Standard Test Method for Determining Apparent Opening Size of a Geotextile
ASTM D 4759	(1988; R-1992) Standard Practice for Determining the Specification Performance of Geosynthetics
ASTM D 4833	(1988) Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.

## 1.2 SHIPMENT AND STORAGE

During shipment and storage, the cloth shall be protected from direct sunlight, ultra-violet rays, temperatures greater than 140 degrees, mud, dirt, dust, and debris. To the maximum extent possible, the cloth shall be maintained wrapped in heavy duty protective covering.

## 1.3 ACCEPTANCE REQUIREMENTS

Geotextile fabric and seams shall be accepted on the following basis. The Contractor shall furnish the Contracting Officer, in duplicate, a mill certificate or affidavit signed by an official from the company manufacturing the geotextile. The mill certificate or affidavit shall state the full product name by trademark and style number, shall indicate the geotextile polymer type(s), and shall attest that the geotextile meets the chemical, physical, and specified requirements. If requested by the

Contracting Officer, the Contractor shall provide geotextile samples for testing to determine compliance. When samples are requested, they shall be submitted a minimum of 60 days prior to the beginning of installation of the geotextile. Samples shall be from the same production lot as will be supplied for installation. Samples shall be identified by manufacturers lot designation and the product machine direction. The machine direction is defined as the roll length direction. Sampling for testing shall be in accordance with ASTM D 4354, and testing procedures shall be in accordance with the methods given in Table 1 at the end of this section. Acceptance/rejection of geotextiles shall be determined in accordance with ASTM D 4759.

## 2 PRODUCTS

### 2.1 MATERIALS

Physical properties of fabric and seams shall conform to requirements shown in TABLE 1.

#### 2.1.1 Geotextile

The geotextile shall be of nonwoven needle punched construction and consist of long-chain polymer fibers composed of at least 85% by weight of polypropylenes. Fabric shall be free of defects including rips, holes, flaws, deterioration, or damage. The fabric shall be inert to chemicals commonly found in soil. The fibers shall be oriented into a multi-directional stable network whereby they retain their positions relative with each other. The edges of the geotextile shall be finished to prevent the outer fiber from pulling away from the geotextile.

#### 2.1.2 Seams

The seams of the geotextile shall be sewn with thread of a material meeting the chemical requirements given above for geotextile yarn. The sheets of geotextile shall be attached at the factory or another approved location, if necessary, to form sections not less than 3.65 meters wide. When used, sewn geotextile seams shall consist of a minimum of one row of stitching. The seam and stitch type used to perform the sewing shall be as recommended by the manufacturer of the geotextile.

#### 2.1.3 Securing Pins

Securing pins shall be of the size and type recommended by the manufacturer and fabricated with a head to retain a steel washer having an outside diameter of not less than 40 mm.

#### 2.1.4 Granular Fill used with Geotextiles

Granular materials shall be sand, crushed stone, crushed gravel, or pea gravel conforming to the requirements of ASTM C 33 and having a gradation of ASTM C 33, Size 67 as follows:

Sieve Size	#Passing
1"	100
3/4"	95 to 100
3/8"	20 to 55
No. 4	0 to 10
No. 200	0 to 5

### 3 EXECUTION

#### 3.1 INSTALLATION

The geotextile shall be placed in the manner and at the locations shown on the drawings. The surface to receive the geotextile shall be prepared to a relatively smooth condition free of obstructions, depressions, debris and soft or low density pockets of material. Erosion features such as rills, gullies, etc. shall be graded out of the surface before geotextile placement. The geotextile shall be placed with the long dimension perpendicular to the slope. The geotextile shall be laid smooth and free of tension, stress, folds, wrinkles, or creases. The strips shall be placed to provide a minimum width of 600 mm of overlap for each joint. Temporary pinning of the textile to help hold it in place until the bedding layer is placed shall be allowed. The temporary pins shall be removed as the bedding is placed to relieve high tensile stress which may occur during placement of material on the geotextile.

The geotextile shall be protected at all times during construction from contamination by surface runoff and any geotextile so contaminated shall be removed and replaced with uncontaminated geotextile. Any damage to the geotextile during its installation or during placement of bedding or riprap shall be replaced. Covering of the geotextile with bedding shall be within 7 calendar days after placement of the geotextile. Failure to comply shall require replacement of geotextile. Before placement of riprap or other bedding materials, the Contractor shall demonstrate that the placement technique will prevent damage to the geotextile. In no case shall any type of equipment be allowed on the unprotected geotextile.

#### 3.2 REPAIR

Geotextile repair shall be in accordance with manufacturer's recommendations.

TABLE 1

PROPERTY	PHYSICAL PROPERTIES (1) TEST PROCEDURE (ASTM)	ACCEPTABLE RESULTS
Grab Tensile Strength, mm	ASTM D 4632	900 minimum
Elongation, %	ASTM D 4632	65 maximum
Seam Strength, mm	ASTM D 4632	700 minimum
Puncture Strength, mm	ASTM D 4833	300 minimum
Trapezoid Tear Strength, mm	ASTM D 4533	400 minimum
Apparent Opening Size (AOS/US Standard Sieve)	ASTM D 4751	
a) Soil with 50% less by weight passing US No. 200 sieve		<0.6mm/#30
b) Soil with more than 50% by weight passing US No. 200 sieve		<0.297mm/#50
Ultraviolet Degradation	ASTM D 4355	70% Strength retained (At 150 hours)

(1) Minimum - Use value in weaker principal direction. All numerical values represent minimum average roll value (i.e., test results from any sampled roll in a lot shall meet or exceed the minimum values).

Ultra-violet resistance of the fabric shall provide strength retention of not less the 60 percent of the original test strength after 500 hours of testing in accordance with ASTM D 4355.

## SECTION 02221

## EXCAVATION, FILLING AND BACKFILLING FOR BUILDINGS

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 1556	(1990) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu. m.))
ASTM D 2216	(1992) Laboratory Determination of Water (Moisture) Content of Soil, and Rock&
ASTM D 2487	(1993) Classification of Soils for Engineering Purposes
ASTM D 2922	(1991) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 4253	(1993) Maximum Index Density of Soils Using a Vibratory Table
ASTM D 4318	(1993) Liquid Limit, Plastic Limit, and Plasticity Index of Soils

## 1.2 DEFINITIONS

## 1.2.1 Degree of Compaction

Degree of compaction is a percentage of the maximum laboratory dry density obtained by the test procedure presented in ASTM D 1557 or ASTM D 4253. ASTM D 1557 shall be used for soils containing 15 percent or more passing the No. 200 sieve (fines). ASTM D 4253 shall be used for soils containing 5 percent or less fines. The maximum laboratory dry density for soils containing between 5 and 15 percent fines shall be determined by the above procedure yielding the highest laboratory dry density. The percentage of material passing the no. 200 sieve shall be determined in accordance with ASTM D 4253. Degree of compaction shall be expressed as a percentage of the maximum laboratory dry density obtained by the appropriate procedure as defined above. Percentage of maximum laboratory dry density has been abbreviated hereinafter as percent laboratory maximum density or percent maximum density.

## 2 PRODUCTS

### 2.1 MATERIALS

#### 2.1.1 Satisfactory Materials

Satisfactory materials include materials classified in ASTM D 2487 as GW, GP, SW, GC, GM, SP, SM, SC, AND CL and shall be free of trash, debris, roots or other organic matter, or stones larger than 3 inches in any dimension.

#### 2.1.2 Unsatisfactory Materials

Unsatisfactory materials include materials classified in ASTM D 2487 as Pt, OH, OL, ML, MH, AND CH and any other materials not defined as satisfactory.

#### 2.1.3 Cohesionless and Cohesive Materials

Cohesionless materials include materials classified in ASTM D 2487 as GW, GP, SW, and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM will be identified as cohesionless only when the fines are nonplastic.

#### 2.1.4 Nonexpansive Fill

Nonexpansive fill is a satisfactory material having a plasticity index equal to or less than 12 when tested in accordance with ASTM D 4318.

### 2.2 CAPILLARY WATER BARRIER

Capillary Water Barrier shall consist of clean, crushed, nonporous rock, crushed gravel, or uncrushed gravel. The maximum particle size shall be 37.5 mm and no more than 2 percent by weight shall pass the 4.75 mm sieve.

## 3 EXECUTION

### 3.1 CLEARING AND GRUBBING

Clearing and grubbing is specified in Section 02230 CLEARING AND GRUBBING. The areas within lines 1.500 m outside of each building and structure line shall be cleared and grubbed of trees, stumps, roots, brush and other vegetation, debris, existing foundations, pavements, utility lines, structures, fences, and other items that would interfere with construction operations. Stumps, logs, roots, and other organic matter shall be completely removed and the resulting depressions shall be filled with satisfactory material, placed and compacted in accordance with paragraph FILLING AND BACKFILLING. Materials removed shall be disposed of outside the limits of Government-controlled property at the Contractor's responsibility.

### 3.2 TOPSOIL

Topsoil shall be stripped to a depth of 150 mm below existing grade within the designated excavations and grading lines and deposited in storage piles for later use. Excess topsoil shall be disposed as specified for excess excavated material.

### 3.3 EXCAVATION

Excavation shall conform to the dimensions and elevations indicated for each building, structure, and footing except as specified hereinafter, and shall include trenching for utility and foundation drainage systems to a point 1.5 m beyond the building line of each building and structure, excavation for outside grease interceptors, underground fuel tanks, and all work incidental thereto. Excavation shall extend a sufficient distance from walls and footings to allow for placing and removal of forms. Where nonexpansive fill is indicated below slabs the excavation shall be performed to the depth required to place the required thickness of nonexpansive fill. Excavations below indicated depths will not be permitted except to remove unsatisfactory material. Unsatisfactory material encountered below the grades shown shall be removed as directed and replaced with nonexpansive material. Payment therefor will be made in conformance with the CHANGES clause of the CONTRACT CLAUSES. Satisfactory material removed below the depths indicated without specific direction of the Contracting Officer shall be replaced at no additional cost to the Government to the indicated excavation grade with nonexpansive fill, except that concrete footings shall be increased in thickness to the bottom of the overdepth excavations and over-break in rock excavation. Nonexpansive fill material shall be placed and compacted as specified in paragraph FILLING AND BACKFILLING. Determination of elevations and measurements of approved overdepth excavation of unsatisfactory material below grades indicated shall be done under the direction of the Contracting Officer.

### 3.4 DRAINAGE AND DEWATERING

#### 3.4.1 Drainage

Surface water shall be directed away from excavation and construction sites so as to prevent erosion and undermining of foundations. The foundation of any shall be protected as required to prevent surface water and rainfall from ponding or being collected within the perimeter of any structure. Diversion ditches, dikes and grading shall be provided and maintained as necessary during construction. Excavated slopes and backfill surfaces shall be protected to prevent erosion and sloughing. Excavation shall be performed so that the site and the area immediately surrounding the site and affecting operations at the site shall be continually and effectively drained.

#### 3.4.2 Dewatering

Groundwater flowing toward or into excavations shall be controlled to prevent sloughing of excavation slopes and walls, boils, uplift and heave in the excavation and to eliminate interference with orderly progress of construction. French drains, sumps, ditches or trenches will not be permitted within 1 meter of the foundation of any structure, except with specific written approval, and after specific contractual provisions for restoration of the foundation area have been made. Control measures shall be taken by the time the excavation reaches the water level in order to maintain the integrity of the in situ material. While the excavation is open, the water level shall be maintained continuously, at least 900 mm below the working level.

### 3.5 SHORING

Shoring, including sheet piling, shall be furnished and installed as necessary to protect workmen, banks, adjacent paving, structures, and utilities. Shoring, bracing, and sheeting shall be removed as excavations are backfilled, in a manner to prevent caving.

### 3.6 CLASSIFICATION OF EXCAVATION

Excavation will be unclassified regardless of the nature of material encountered.

### 3.7 BLASTING

Blasting will not be permitted.

### 3.8 UTILITY AND DRAIN TRENCHES

Trenches for underground utilities systems and drain lines shall be excavated to the required alignments and depths. The bottoms of trenches shall be graded to secure the required slope and shall be tamped if necessary to provide a firm pipe bed. Recesses shall be excavated to accommodate bells and joints so that pipe will be uniformly supported for the entire length. Rock, where encountered, shall be excavated to a depth of at least 150 mm below the bottom of the pipe, and the overdepth shall be backfilled with nonexpansive fill placed and compacted in conformance with paragraph FILLING AND BACKFILLING.

### 3.9 EXCAVATED MATERIALS

Satisfactory excavated material required for fill or backfill shall be placed in the proper section of the permanent work required under this section or shall be separately stockpiled if it cannot be readily placed.

### 3.10 FINAL GRADE OF SURFACES TO SUPPORT CONCRETE

Excavation to final grade shall not be made until just before concrete is to be placed. Only excavation methods that will leave the foundation rock in a solid and unshattered condition shall be used. Approximately level surfaces shall be roughened, and sloped surfaces shall be cut as indicated into rough steps or benches to provide a satisfactory bond. Shales shall be protected from slaking or other erosion resulting from ponding or flow of water.

### 3.11 SUBGRADE PREPARATION

Unsatisfactory material in surfaces to receive fill or in excavated areas shall be removed and replaced with satisfactory materials. The surface shall be scarified to a depth of 150 mm before the fill is started. Sloped surfaces steeper than 1 vertical to 4 horizontal shall be plowed, stepped, benched, or broken up so that the fill material will bond with the existing material. When subgrades are less than the specified density, the ground surface shall be broken up to a minimum depth of 150 mm, pulverized, and compacted to the specified density. When the subgrade is part fill and part excavation or natural ground, the excavated or natural ground portion shall be scarified to a depth of 300 mm and compacted as specified for the adjacent fill. Material shall not be placed on surfaces that are muddy, frozen, or contain frost. Compaction shall be accomplished by sheepsfoot



rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved equipment well suited to the soil being compacted. Material shall be moistened or aerated as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used. Minimum subgrade density shall be as specified in paragraph FILLING AND BACKFILLING.

### 3.12 FILLING AND BACKFILLING

Satisfactory materials shall be used in bringing fills and backfills to the lines and grades indicated and for replacing unsatisfactory materials. All satisfactory materials placed under buildings, structures, and footings shall be nonexpansive fill. Satisfactory materials shall be placed in horizontal layers not exceeding 200 mm in loose thickness, or 150 mm when hand-operated compactors are used. After placing, each layer shall be plowed, disked, or otherwise broken up, moistened or aerated as necessary, thoroughly mixed and compacted as specified. Backfilling shall not begin until construction below finish grade has been approved, underground utilities systems have been inspected, tested and approved, forms removed, and the excavation cleaned of trash and debris. Backfill shall be brought to indicated finish grade and shall include backfill for outside grease interceptors and underground fuel tanks. Backfill shall not be placed in wet or frozen areas. Where pipe is coated or wrapped for protection against corrosion, the backfill material up to an elevation 600 mm above sewer lines and 300 mm above other utility lines shall be free from stones larger than 25.4 mm in any dimension. Heavy equipment for spreading and compacting backfill shall not be operated closer to foundation or retaining walls than a distance equal to the height of backfill above the top of footing; the area remaining shall be compacted in layers not more than 100 mm in compacted thickness with power-driven hand tampers suitable for the material being compacted. Backfill shall be placed carefully around pipes or tanks to avoid damage to coatings, wrappings, or tanks. Backfill shall not be placed against foundation walls prior to 7 days after completion of the walls. As far as practicable, backfill shall be brought up evenly on each side of the wall and sloped to drain away from the wall. Using the appropriate laboratory maximum dry density test procedure as defined in Part 1 above, each layer of fill and backfill shall be compacted to not less than the percentage of maximum density specified below:

	Percent Laboratory maximum density	
	ASTM D 1557	ASTM D 4253
Fill, embankment, and backfill		
Under structures, building slabs, steps, paved areas, around footings, and in trenches	90	95
Under sidewalks and grassed areas	85	90

	Percent Laboratory maximum density	
	ASTM D 1557	ASTM D 4253
<hr/>		
Fill, embankment, and backfill		
<hr/>		
Nonexpansive fill	92	92
Subgrade		
<hr/>		
Under building slabs, steps, and paved areas, top 300 mm	90	95
Under sidewalks, top 150 mm	85	90

Approved compacted subgrades that are disturbed by the Contractor's operations or adverse weather shall be scarified and compacted as specified herein before to the required density prior to further construction thereon. Recompectation over underground utilities and heating lines shall be by hand tamping.

### 3.13 TESTING

Testing shall be the responsibility of the Contractor and shall be performed at no additional cost to the Government. Testing shall be performed by an approved commercial testing laboratory or may be performed by the Contractor subject to approval. If the Contractor elects to establish testing facilities, no work requiring testing will be permitted until the Contractor's facilities have been inspected and approved by the Contracting Officer. Field in-place density shall be determined in accordance with ASTM D 1556 or ASTM D 2922. If ASTM D 2922 is used, in-place densities shall be checked by the ASTM D 1556 procedure at a frequency of one sand cone test for each 8 nuclear density tests and not less than one sand cone density test per lift. The sand cone test shall be performed adjacent to the location where a nuclear density test was performed to insure a proper correlation is established between the two density test procedures. When test results indicate, as determined by the Contracting Officer, that compaction is not as specified, the material shall be removed, replaced and recompacted to meet specification requirements, at no additional expense to the Government. Tests on recompacted areas shall be performed to determine conformance with specification requirements. Moisture contents shall be determined in accordance with ASTM D 4643 and/or ASTM D 2216. If the ASTM D 4643 procedure is used, moisture contents shall be checked by the ASTM D 2216 procedure once per each 10 ASTM D 4643 tests. The following number of tests, if performed at the appropriate time, shall be the minimum acceptable for each type operation.

### 3.13.1 In-Place Densities

#### 3.13.1.1 In-Place Density of Subgrades

One test per 185 square meters or fraction thereof.

#### 3.13.1.2 In-Place Density of Fills and Backfills

One test per or fraction thereof of each lift for fill or backfill areas compacted by other than hand or hand-operated machines. The density for each lift of fill or backfill materials for trenches, pits, building perimeters or other structures or areas less than 1800 mm in width, which are compacted with hand or hand-operated machines shall be tested as follows: One test per each area less than 10 square meters, or one test for each 15 m of long narrow fills 30 m or more in length.

### 3.13.2 Moisture Content

Moisture contents shall be determined on materials obtained from each density sample location.

### 3.13.3 Optimum Moisture and Laboratory Maximum Density

The laboratory maximum dry density shall be determined from materials obtained at a sand cone test location using the appropriate procedure specified in Part 1 above. When ASTM D 1557 is used, the optimum moisture content shall be determined. A minimum of one laboratory maximum dry density test shall be run each placement day or fraction thereof. Additional laboratory maximum dry density tests shall be run for each material change.

### 3.14 CAPILLARY WATER BARRIER

Capillary water barrier under concrete floor and area-way slabs on grade shall be placed directly on the subgrade and shall be compacted with a minimum of two passes of a hand-operated plate-type vibratory compactor.

### 3.15 GRADING

Areas within 1500 mm outside of each building and structure line shall be constructed true-to-grade, shaped to drain, and shall be maintained free of trash and debris until final inspection has been completed and the work has been accepted.

### 3.16 SPREADING TOPSOIL

Areas outside the building lines from which topsoil has been removed shall be topsoiled. The surface shall be free of materials that would hinder planting or maintenance operations. The subgrade shall be pulverized to a depth of 50 mm by disking or plowing for the bonding of topsoil with the subsoil. Topsoil shall then be uniformly spread, graded, and compacted to the thickness, elevations, slopes shown, and left free of surface irregularities. Topsoil shall be compacted by one pass of a cultipacker, roller, or other approved equipment weighing 1.46 kN/m to 2.34 kN/m of roller. Topsoil shall not be placed when the subgrade is frozen, excessively wet, extremely dry, or in a condition otherwise detrimental to seeding, planting, or proper grading.

3.17 PROTECTION

Settlement or washing that occurs in graded, topsoiled, or backfilled areas prior to acceptance of the work shall be repaired and grades reestablished to the required elevations and slopes.

## SECTION 02222

## EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 1556	(1990) Density of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1991) Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-in. (457-mm) Drop
ASTM D 2216	(1992) Laboratory Determination of Water (Moisture) Content of Soil and Rock
ASTM D 2487	(1993) Classification of Soils for Engineering Purposes
ASTM D 2922	(1991) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 4253	(1991) Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
ASTM D 4643	(1987) Determination of Water (Moisture) Content of soil by the Microwave Oven Method

## 1.2 DEFINITIONS

## 1.2.1 Degree of Compaction

Degree of compaction is a percentage of the maximum laboratory dry density obtained by the test procedure presented in ASTM D 1557 or ASTM D 4253. ASTM D 1557 shall be used for soils containing 15 percent or more passing the No. 200 sieve (fines). ASTM D 4253 shall be used for soils containing 5 percent or less fines. The maximum laboratory dry density for soils containing between 5 and 15 percent fines shall be determined by the above procedure yielding the highest laboratory dry density. The percentage of material passing the No. 200 sieve shall be determined in accordance with ASTM D 4253. Degree of compaction shall be expressed as a percentage of the maximum laboratory dry density obtained by the appropriate procedure as defined above. Percentage of maximum laboratory dry density has been abbreviated hereinafter as percent laboratory maximum density.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The

following shall be submitted in accordance with Section 01300: SUBMITTAL DESCRIPTIONS:

SD-09 Reports

Field Density Tests; GA.

Copies of all laboratory and field test reports within 24 hours of the completion of the test.

2 PRODUCTS

2.1 MATERIALS

2.1.1 Satisfactory Materials

Satisfactory materials shall consist of any material classified by ASTM D 2487 as GW, GP, CG, GM, SW, SP, SM, SC, and CL and shall be free of trash, debris, roots or other organic matter, or stones larger than 150 mm in any dimension.

2.1.2 Unsatisfactory Materials

Unsatisfactory materials shall include materials classified in ASTM D 2487, as PT, OH, OL, ML, MH, and CH and any other materials not defined as satisfactory. Unsatisfactory materials also include man-made fills, refuse, or backfills from previous construction.

2.1.3 Cohesionless and Cohesive Materials

Cohesionless materials shall include materials classified in ASTM D 2487 as GW, GP, SW, and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM will be identified as cohesionless only when the fines are nonplastic.

2.1.4 Rock

Rock shall consist of boulders measuring 1/2 cubic meter or more and materials that cannot be removed without systematic drilling and blasting such as rock material in ledges, bedded deposits, unstratified masses and conglomerate deposits, and below ground concrete or masonry structures, exceeding 1/2 cubic meter in volume, except that pavements will not be considered as rock.

2.1.5 Unyielding Material

Unyielding material shall consist of rock and gravelly soils with stones greater than 0.075 meters in any dimension or as defined by the pipe manufacturer, whichever is smaller.

2.1.6 Unstable Material

Unstable material shall consist of materials too wet to properly support the utility pipe, conduit, or appurtenant structure.

### 2.1.7 Select Granular Material

Select granular material shall consist of well-graded sand, gravel, crushed gravel, crushed stone or crushed slag composed of hard, tough and durable particles, and shall contain not more than 10 percent by weight of material passing a 0.075 mm mesh sieve and no less than 95 percent by weight passing the 1-inch sieve. The maximum allowable aggregate size shall be 76 mm, or the maximum size recommended by the pipe manufacturer, whichever is smaller.

### 2.1.8 Initial Backfill Material

Initial backfill shall consist of select granular material or satisfactory materials free from rocks 51 mm or larger in any dimension or free from rocks of such size as recommended by the pipe manufacturer, whichever is smaller.

### 2.1.9 Plastic Marking Tape

Plastic marking tape shall be acid and alkali-resistant polyethylene film, 152 mm wide with minimum thickness of 0.102 mm. Tape shall have a minimum strength of 12.1 MPa lengthwise and 10.3 MPa crosswise. The tape shall be manufactured with integral wires, foil backing or other means to enable detection by a metal detector when the tape is buried up to 900 mm deep. The tape shall be of a type specifically manufactured for marking and locating underground utilities. The metallic core of the tape shall be encased in a protective jacket or provided with other means to protect it from corrosion. Tape color shall be as specified in TABLE 1 and shall bear a continuous printed inscription describing the specific utility.

TABLE 1. Tape Color

Red:	Electric
Yellow:	Gas, Oil, Dangerous Materials
Orange:	Telephone, Telegraph, Television, Police, and Fire Communications
Blue:	Water Systems
Green:	Sewer Systems

## 3 EXECUTION

### 3.1 EXCAVATION

Excavation shall be performed to the lines and grades indicated. Rock excavation shall include removal and disposition of material defined as rock in paragraph MATERIALS. Earth excavation shall include removal and disposal of material not classified as rock excavation. During excavation, material satisfactory for backfilling shall be stockpiled in an orderly manner at a distance from the banks of the trench equal to 1/2 the depth of the excavation, but in no instance closer than 300 mm. Excavated material not required or not satisfactory for backfill shall be removed from the site. Grading shall be done as may be necessary to prevent surface water from flowing into the excavation, and any water accumulating therein shall be removed to maintain the stability of the bottom and sides of the excavation. Unauthorized overexcavation shall be backfilled in accordance with paragraph BACKFILLING AND COMPACTION at no additional cost to the Government.

### 3.1.1 Trench Excavation

The trench shall be excavated as recommended by the manufacturer of the pipe to be installed. Trench walls below the top of the pipe shall be sloped, or made vertical, and of such width as recommended in the manufacturer's installation manual. Where no manufacturer's installation manual is available, trench walls shall be made vertical. Trench walls which are cut back shall be excavated to at least the angle of repose of the soil. Special attention shall be given to slopes which may be adversely affected by weather or moisture content. The trench width below the top of pipe shall not exceed 600 mm plus pipe outside diameter (O.D.) for pipes of less than 600 mm inside diameter and shall not exceed 900 mm plus pipe outside diameter for sizes larger than 600 mm inside diameter. Where recommended trench widths are exceeded, redesign, stronger pipe, or special installation procedures shall be utilized by the Contractor. The cost of redesign, stronger pipe, or special installation procedures shall be borne by the Contractor without any additional cost to the Government.

#### 3.1.1.1 Bottom Preparation

The bottoms of trenches shall be accurately graded to provide uniform bearing and support for the bottom quadrant of each section of the pipe. Bell holes shall be excavated to the necessary size at each joint or coupling to eliminate point bearing. Stones of 75 mm or greater in any dimension, or as recommended by the pipe manufacturer, whichever is smaller, shall be removed to avoid point bearing.

#### 3.1.1.2 Removal of Unyielding Material

Where unyielding material is encountered in the bottom of the trench, such material shall be removed 150 mm below the required grade and replaced with suitable materials as provided in paragraph BACKFILLING AND COMPACTION.

#### 3.1.1.3 Removal of Unstable Material

Where unstable material is encountered in the bottom of the trench, such material shall be removed to the depth directed and replaced to the proper grade with select granular material as provided in paragraph BACKFILLING AND COMPACTION. When removal of unstable material is required due to the fault or neglect of the Contractor in his performance of the work, the resulting material shall be excavated and replaced by the Contractor without additional cost to the Government.

#### 3.1.1.4 Excavation for Appurtenances

Excavation for manholes, inlets, or similar structures shall be sufficient to leave at least 300 mm clear between the outer structure surfaces and the face of the excavation or support members. Rock shall be cleaned of loose debris and cut to a firm surface either level, stepped, or serrated, as shown or as directed. Loose disintegrated rock and thin strata shall be removed. Removal of unstable material shall be as specified above. When concrete or masonry is to be placed in an excavated area, special care shall be taken not to disturb the bottom of the excavation. Excavation to the final grade level shall not be made until just before the concrete or masonry is to be placed.



### 3.1.1.5 Jacking and Boring

Unless otherwise indicated, excavation shall be by open cut except that street crossings of a trench shall be jacked or bored as follows:

Jacking or boring pipe shall be with approved procedures. Pipe and conduit smaller than 900 mm in diameter shall be installed in a smooth standard weight steel pipe casing. A minimum clearance of at least 50 mm between the inner wall of the sleeve and maximum outside diameter of the sleeved pipe and joint shall be provided. Sand bedding shall be provided for the utility pipe or conduit through the sleeve. The Contractor shall submit the plan of his proposed installation procedures for approval.

The plan shall include pipe guides, jack positions, jacking head, tunnel liner when required, jointing methods, and other specifics pertinent to the procedure selected.

#### a. Jacking

If the grade of the pipe at the jacking end is below the ground surface, suitable pits or trenches shall be excavated for the purpose of conducting the jacking operations and for placing end joints of the pipe. Wherever end trenches are cut in the sides of the embankment or beyond it, such work shall be sheathed securely and braced in a satisfactory manner to prevent earth caving. Construction shall be made in such a manner that will not interfere with the operation of the street and shall not weaken or damage any embankment or structure. During construction operations, barricades and lights to safeguard traffic and pedestrians shall be furnished and maintained, as directed by the Contracting Officer, until such time as the backfill has been completed and then shall be removed from the site. Heavy duty jacks suitable for forcing the pipe through the embankment shall be provided. In operating jacks, even pressure shall be applied to all jacks used. A suitable jacking head, usually of timber, and suitable bracing between jacks and jacking head shall be provided so that pressure will be applied to the pipe uniformly around the ring of the pipe. A suitable jacking frame or back stop shall be provided. The pipe to be jacked shall be set on guides, properly braced together to support the section of the pipe and to direct it in the proper line and grade. The whole jacking assembly shall be placed so as to line up with the direction and grade of the pipe. In general, embankment material shall be excavated just ahead of the pipe and material removed through the pipe, and the pipe forced through the embankment with jacks, into the space thus provided. The distance that the excavation shall extend beyond the end of the pipe depends on the character of the material, but it shall not exceed 2 feet in any case. This distance shall be decreased on instructions from the Contracting Officer, if the character of the material being excavated makes it desirable to keep the advance excavation closer to the end of the pipe. The pipe, preferably, shall be jacked from the low or downstream end. Lateral or vertical variation in the final position of the pipe from the line and grade established by the Contracting Officer will be permitted only to the extent of 1-inch in 10 feet, provided that such variation shall be regular and only in one direction and that the final grade of flow line shall be in the direction indicated on the plans. If the Contractor desires, he may use a cutting edge of steel plate around the head end of the pipe extending a short distance beyond the end of the pipe with inside angles or lugs to keep the cutting edge from slipping back onto the pipe. When jacking of pipe is once begun, the operation shall be carried on without interruption, insofar as practicable, to prevent the pipe from becoming firmly set in the

embankment. Any pipe damaged in jacking operations shall be removed and replaced by the Contractor at his entire expense. The pits or trenches excavated to facilitate jacking operations shall be backfilled immediately after the jacking of the pipe has been completed.

#### b. Boring

The boring shall proceed from a pit provided for the boring equipment and workmen. Excavation for pits and installation of shoring shall be as outlined above under paragraph Jacking. The location of the pit shall meet the approval of the Contracting Officer. The holes are to be bored mechanically. The boring shall be done using a pilot hole. By this method an approximate 50 mm pilot hole shall be bored the entire length of the crossing and shall be checked for line and grade on the opposite end of the bore from the work pit. This pilot hole shall serve as the centerline of the larger diameter hole to be bored. Excavated material will be placed near the top of the working pit and disposed of as required. The use of water or other fluids in connection with the boring operation will be permitted only to the extent to lubricate cuttings; jetting will not be permitted. In unconsolidated soil formations, a gel-forming colloidal drilling fluid consisting of at least 10 percent of high grade carefully processed bentonite may be used to consolidate cuttings of the bit, seal the walls of the hole, and furnish lubrication for subsequent removal of cuttings and installation of the pipe immediately thereafter. Allowable variation from line and grade shall be as specified under paragraph Jacking. Overcutting in excess of 25 mm shall be remedied by pressure grouting the entire length of the installation.

#### 3.1.1.6 Stockpiles

Stockpiles of satisfactory materials shall be placed and graded as specified. Stockpiles shall be kept in a neat and well drained condition, giving due consideration to drainage at all times. The ground surface at stockpile locations shall be cleared, grubbed, and sealed by rubber-tired equipment, excavated satisfactory and unsatisfactory materials shall be separately stockpiled. Stockpiles of satisfactory materials shall be protected from contamination which may destroy the quality and fitness of the stockpiled material. If the Contractor fails to protect the stockpiles, and any material becomes unsatisfactory, such material shall be removed and replaced with satisfactory material from approved sources at no additional cost to the Government. Locations of stockpiles of satisfactory materials shall be subject to prior approval of the Contracting Officer.

### 3.2 BACKFILLING AND COMPACTION

Backfill material shall consist of satisfactory material, select granular material, or initial backfill material as required. Backfill shall be placed in layers not exceeding 150 mm loose thickness for compaction by hand operated machine compactors, and 200 mm loose thickness for other than hand operated machines, unless otherwise specified. Each layer shall be compacted to at least 95 percent maximum density for cohesionless soils and 90 percent maximum density for cohesive soils, unless otherwise specified.

#### 3.2.1 Trench Backfill

Trenches shall be backfilled to the grade shown. The trench shall be backfilled to 600 mm above the top of pipe or as recommended by the pipe

manufacturer prior to performing the required pressure tests. The joints and couplings shall be left uncovered during the pressure test. The trench shall not be backfilled until all specified tests are performed.

#### 3.2.1.1 Replacement of Unyielding Material

Unyielding material removed from the bottom of the trench shall be replaced with select granular material or initial backfill material.

#### 3.2.1.2 Replacement of Unstable Material

Unstable material removed from the bottom of the trench or excavation shall be replaced with select granular material placed in layers not exceeding 150 mm loose thickness.

#### 3.2.1.3 Bedding and Initial Backfill

Bedding shall be of the type and thickness shown. Initial backfill material shall be placed and compacted with approved tampers to a height of at least one foot above the utility pipe or conduit. The backfill shall be brought up evenly on both sides of the pipe for the full length of the pipe. Care shall be taken to ensure thorough compaction of the fill under the haunches of the pipe and around the pipe.

#### 3.2.1.4 Final Backfill

The remainder of the trench shall be filled with satisfactory material. Backfill material shall be placed and compacted as follows:

a. Sidewalks, Turfed or Seeded Areas and Miscellaneous Areas: Backfill shall be deposited in layers of a maximum of 300 mm loose thickness, and shall be compacted to at least 90 percent of laboratory maximum density. Areas to be paved and other areas indicated as requiring compaction suitable for paved areas shall be compacted to at least 90 percent of maximum laboratory density and 95 percent of maximum laboratory density for the applicable ASTM D1557 and ASTM D 4253 procedure, respectively.

This requirement shall also apply to all other areas not specifically designated above.

#### 3.2.2 Backfill for Appurtenances

After the manhole, inlet, or similar structure has been constructed and the concrete has been allowed to cure for a minimum of three days, backfill shall be placed in such a manner that the structure will not be damaged by the shock of falling earth. The backfill material shall be deposited and compacted as specified for final backfill, and shall be brought up evenly on all sides of the structure to prevent eccentric loading and excessive stress.

#### 3.3 SPECIAL REQUIREMENTS

Special requirements for both excavation and backfill relating to the specific utilities are as follows:

### 3.3.1 Gas Distribution

Trenches shall be excavated to a depth that will provide not less than 400 mm of cover in rock excavation and not less than 600 mm of cover in other excavation. Trenches shall be graded as specified for pipe-laying requirements in Section 02685 GAS DISTRIBUTION SYSTEM.

### 3.3.2 Water Lines

Trenches shall be of a depth to provide a minimum cover of 900 mm from the existing ground surface, or from the indicated finished grade, whichever is lower, to the top of the pipe.

### 3.3.3 Heat Distribution System

Initial backfill material shall be free of stones larger than 6 mm in any dimension.

### 3.3.4 Electrical Distribution System

Direct burial cable and conduit or duct line shall have a minimum cover of 600 mm from the finished grade, unless otherwise indicated.

### 3.3.5 Plastic Marking Tape

Warning tapes shall be installed directly above the pipe, at a depth of 400 mm below finished grade unless otherwise shown.

## 3.4 TESTING

Testing shall be the responsibility of the Contractor and shall be performed at no additional cost to the Government. Testing shall be performed by an approved commercial testing laboratory or may be performed by the Contractor subject to approval. If the Contractor elects to establish testing facilities, no work requiring testing will be permitted until the Contractor's facilities have been inspected and approved by the Contracting Officer. Moisture contents shall be determined in accordance with ASTM D 4643 and/or ASTM D 2216. If the ASTM D 4643 procedure is used, moisture contents shall be checked by the ASTM D 2216 procedure once per each 10 ASTM D 4643 tests. Field in-place density shall be determined in accordance with ASTM D 1556 or ASTM D 2922. If ASTM D 2922 is used, in-place densities shall be checked by the ASTM D 1556 procedure at a frequency on one sand cone test for each 8 nuclear density tests and not less than one sand cone density test per lift. The sand cone test shall be performed adjacent to the location where a nuclear density test was performed to insure a proper correlation is established between the two density test procedures. When test results indicate, as determined by the Contracting Officer, that compaction is not as specified, the material shall be removed, replaced and recompacted to meet specification requirements, at no additional expense to the Government. Tests on recompacted areas shall be performed to determine conformance with specification requirements. The following number of tests, if performed at the appropriate time, shall be the minimum acceptable for each type operation:

Tests shall be performed in sufficient numbers to ensure that the specified density is being obtained. A minimum of one field density test per lift of backfill for every 60 m of installation shall be performed. One moisture

density relationship shall be determined for every 500 cubic meters of material used.

#### 3.4.1 Moisture Content

Moisture contents shall be determined on materials obtained from each density sample location.

#### 3.4.2 Optimum Moisture and Laboratory Maximum Dry Density

The laboratory maximum dry density shall be determined from materials obtained at a sand cone test location using the appropriate procedure specified in Part 1 above. When ASTM D 1557 is used, the optimum moisture content shall be determined. A minimum of one laboratory maximum dry density test shall be run each placement day or fraction thereof. Additional laboratory maximum dry density tests shall be run for each material change.

#### 3.4.3 Displacement of Sewers

After other required tests have been performed and the trench backfill compacted to 300 mm above the top of the pipe, the pipe shall be inspected to determine whether significant displacement has occurred. This inspection shall be conducted in the presence of the Contracting Officer. Pipe sizes larger than 900 mm shall be entered and examined, while smaller diameter pipe shall be inspected by shining a light or laser between manholes or manhole locations, or by the use of television cameras passed through the pipe. If, in the judgement of the Contracting Officer, the interior of the pipe shows poor alignment or any other defects that would cause improper functioning of the system, the defects shall be remedied as directed at no additional cost to the Government.

## SECTION 02225

## EARTHWORK FOR ROADWAYS

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 1557	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu. m.))
ASTM D 2487	(1990) Classification of Soils for Engineering Purposes
ASTM D 4253	(1991) Maximum Index Density and Unit Weight of Soils Using a Vibratory Table

## 1.2 DEFINITIONS

## 1.2.1 Satisfactory Materials

Materials classified in ASTM D 2487 as GW, GP, and SW, GC, GM, SP, SM, SC, and CL and shall be free from roots and other organic matter, trash, debris, and frozen materials and stones larger than 6 inches in any dimension are satisfactory.

## 1.2.2 Unsatisfactory Materials

Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Materials classified in ASTM D 2487 as Pt, OH, OL, ML, MH, AND CH and any other materials not defined as satisfactory.

## 1.2.3 Cohesionless and Cohesive Materials

Cohesionless materials include materials classified in ASTM D 2487 as GW, GP, SW, and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM will be identified as cohesionless only when the fines are nonplastic.

## 1.2.4 Degree of Compaction

Degree of compaction is a percentage of the maximum laboratory dry density obtained by the test procedure presented in ASTM D 1557 or ASTM D 4253. ASTM D 1557 shall be used for soils containing 15 percent or more passing the no. 200 sieve (fines). ASTM D 4253 shall be used for soils containing 5 percent or less fines. The maximum laboratory dry density for soils containing between 5 and 15 percent fines shall be determined by the above procedure yielding the highest laboratory dry density. The percentage of material passing the no. 200 sieve shall be determined in accordance with ASTM D

4253. Degree of compaction shall be expressed as a percentage of the maximum laboratory dry density obtained by the appropriate procedure as defined above. Percentage of maximum laboratory dry density has been abbreviated hereinafter as percent laboratory maximum density.

### 1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL DESCRIPTIONS:

#### SD-09 Reports

Testing; GA.

Within 24 hours of conclusion of physical tests, 3 copies of test results, including calibration curves and results of calibration tests.

#### SD-13 Certificates

Testing; GA.

Qualifications of the commercial testing laboratory or Contractor's testing facilities.

### 1.4 CLASSIFICATION OF EXCAVATION

No consideration will be given to the nature of the materials, and all excavation will be designated as unclassified excavation.

#### 1.4.1 Rock Excavation

Rock excavation shall include excavating, grading, and disposing of material classified as rock and shall include the satisfactory removal and disposition of boulders 1/2 cubic meter or more in volume; solid rock; and conglomerate deposits that are so firmly cemented as to possess the characteristics of solid rock that is impossible to remove without systematic drilling. The removal of any concrete or masonry structures, except pavements, exceeding 1/2 cubic meter in volume that may be encountered in the work shall be included in this classification.

If at any time during excavation, the Contractor encounters material that may be classified as rock excavation, such material shall be uncovered and the Contracting Officer notified by the Contractor. The Contractor shall not proceed with the excavation of this material until the Contracting Officer has classified the materials as common excavation or rock excavation and has taken cross sections as required. Failure on the part of the Contractor to uncover such material, notify the Contracting Officer, and allow ample time for classification and cross sectioning of the undisturbed surface of such material will cause the forfeiture of the Contractor's right of claim to any classification or volume of material to be paid for other than that allowed by the Contracting Officer for the areas of work in which such deposits occur.

#### 1.4.2 Common Excavation

Common excavation shall include the satisfactory removal and deposition of all materials not classified as rock excavation.

#### 1.5 BLASTING

Blasting will not be permitted.

#### 1.6 UTILIZATION OF EXCAVATED MATERIALS

All unsatisfactory materials removed from excavations shall be disposed of in designated waste disposal or spoil areas. Satisfactory material removed from excavations shall be used, insofar as practicable, in the construction of fills, embankments, subgrades, shoulders, bedding (as backfill), and for similar purposes. No satisfactory excavated material shall be wasted without specific written authorization. Satisfactory material authorized to be wasted shall be disposed of in designated areas approved for surplus material storage or designated waste areas as directed.

Newly designated waste areas on Government-controlled land shall be cleared and grubbed before disposal of waste material thereon. Coarse rock from excavations shall be stockpiled and used for constructing slopes or embankments adjacent to streams, or sides and bottoms of channels and for protecting against erosion. No excavated material shall be disposed of in such a manner as to obstruct the flow of any stream, endanger a partly finished structure, impair the efficiency or appearance of any structure, or be detrimental to the completed work in any way.

### 2 PRODUCTS (NOT APPLICABLE)

### 3 EXECUTION

#### 3.1 STRIPPING OF TOPSOIL

Where indicated or directed, topsoil shall be stripped to a depth of 150 mm. Topsoil shall be spread on areas already graded and prepared for topsoil, or when so specified topsoil shall be transported and deposited in stockpiles convenient to areas that are to receive application of the topsoil later, or at locations indicated or specified. Topsoil shall be kept separate from other excavated materials, brush, litter, objectionable weeds, roots, stones larger than 2 inches in diameter, and other materials that would interfere with planting and maintenance operations.

#### 3.2 EXCAVATION

The Contractor shall perform excavation of every type of material encountered within the limits of the project, to the lines, grades, and elevations indicated and as specified herein. Grading shall be in conformity with the typical sections shown and the tolerances specified in paragraph FINISHING. Satisfactory excavated materials shall be transported to and placed in fill or embankment within the limits of the work.

Unsatisfactory materials encountered within the limits of the work shall be excavated below grade and replaced with satisfactory materials as directed. Payment therefor will be made in accordance with the Changes Clause of the CONTRACT CLAUSES.



Surplus satisfactory excavated material not required for fill or embankment shall be disposed of in areas approved for surplus material storage or designated waste areas. Unsatisfactory excavated material shall be disposed of in designated waste or spoil areas. During construction, excavation and fill shall be performed in a manner and sequence that will provide proper drainage at all times. Material required for fill or embankment in excess of that produced by excavation within the grading limits shall be excavated from the borrow areas indicated or from other approved areas selected by the Contractor as specified herein.

#### 3.2.1 Ditches, Gutters, and Channel Changes

Excavation of ditches shall be accomplished by cutting accurately to the cross sections, grades, and elevations shown. Care shall be taken not to excavate ditches below grades shown. Excessive open ditch excavation shall be backfilled with satisfactory thoroughly compacted material or with suitable stone or cobble to grades shown at no additional cost to the Government. Material excavated shall be disposed of as shown or as directed, except that in no case shall material be deposited less than 1.5 meters from the edge of a ditch. The Contractor shall maintain all excavations free from detrimental quantities of leaves, brush, sticks, trash, and other debris until final acceptance of the work.

#### 3.3 GRADING AREAS

When so provided and where indicated, work under contract will be divided into grading areas, within which satisfactory excavated material shall be placed in embankments, fills, and required backfills. The Contractor shall not haul satisfactory material excavated in one grading area to another grading area except when so directed in writing.

#### 3.4 BACKFILL

Backfill adjacent to any and all types of structures shall be placed and compacted to at least 90 percent laboratory maximum density for cohesive materials or 95 percent laboratory maximum density for cohesionless materials, in such a manner as to prevent wedging action or eccentric loading upon or against any structure. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment well suited to the material being compacted.

#### 3.5 FINISHING

The surface of all excavations, embankments, and subgrades shall be finished to a smooth and compact surface in accordance with the lines, grades, and cross sections or elevations shown. The degree of finish for all graded areas shall be within 30 mm of the grades and elevations indicated. Ditches shall be finished in a manner that will result in effective drainage.

## SECTION 02230

## CLEARING AND GRUBBING

## 1 GENERAL

## 1.1 DEFINITIONS

## 1.1.1 Clearing

Clearing shall consist of the felling, trimming, and cutting of trees into sections and the satisfactory disposal of the trees and other vegetation designated for removal, including down timber, snags, brush, and rubbish occurring in the areas to be cleared.

## 1.1.2 Grubbing

Grubbing shall consist of the removal and disposal of stumps, roots larger than 75 mm in diameter, and matted roots from the designated grubbing areas.

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-18 Records

Cleared and Grubbed Materials; FIO.

Written permission to dispose of such materials on private property shall be filed with the Contracting Officer.

## 2 PRODUCTS (NOT APPLICABLE)

## 3 EXECUTION

## 3.1 CLEARING

Trees, stumps, roots, brush, and other vegetation in areas to be cleared shall be cut off flush with or below the original ground surface, except such trees and vegetation as may be indicated or directed to be left standing. Trees designated to be left standing within the cleared areas shall be trimmed of dead branches 40 mm or more in diameter and shall be trimmed of all branches the heights indicated or directed. Limbs and branches to be trimmed shall be neatly cut close to the bole of the tree or main branches. Cuts more than 40 mm in diameter shall be painted with an approved tree-wound paint. Trees and vegetation to be left standing shall be protected from damage incident to clearing, grubbing, and construction operations by the erection of barriers or by such other means as the circumstances require. Clearing shall also include the removal and disposal of structures that obtrude, encroach upon, or otherwise obstruct the work.

### 3.2 GRUBBING

Material to be grubbed, together with logs and other organic or metallic debris not suitable for foundation purposes, shall be removed to a depth of not less than 455 mm below the original surface level of the ground in areas indicated to be grubbed and in areas indicated as construction areas under this contract, such as areas for buildings, and areas to be paved. Depressions made by grubbing shall be filled with suitable material and compacted to make the surface conform with the original adjacent surface of the ground.

### 3.3 TREE REMOVAL

Where indicated or directed, trees and stumps that are designated as trees shall be removed from areas outside those areas designated for clearing and grubbing. This work shall include the felling of such trees and the removal of their stumps and roots as specified in paragraph GRUBBING. Trees shall be disposed of as specified in paragraph DISPOSAL OF MATERIALS.

### 3.4 DISPOSAL OF MATERIALS

Logs, stumps, roots, brush, rotten wood, and other refuse from the clearing and grubbing operations, shall be disposed of outside the limits of Government-controlled land at the Contractor's responsibility, except when otherwise directed in writing. Such directive will state the conditions covering the disposal of such products and will also state the areas in which they may be placed.

## SECTION 02231

## STONE PROTECTION

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 88	(1990) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C 127	(1993,e1) Standard Test Method for Specific Gravity and Absorption of Coarse Aggregate
ASTM C 535	(1996,e1) Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

## 2 PRODUCTS

## 2.1 MATERIAL

## 2.1.1 General

Stone for protection work shall be durable stone as approved by the Contracting Officer. Gypsum, anhydrite, chert, shale, and soft or weathered rock will not be approved. The sources from which the Contractor proposes to obtain the material shall be selected well in advance of the time when the material will be required in the work. Selected stone from the required excavation may be used if satisfying all requirements as to quality and dimensions. Suitable test samples of stone protection material shall be obtained by the Contractor under the direct supervision of the Contracting Officer, and shall be delivered to a point at the project site designated by the Contracting Officer. All costs of delivery of test samples will be at the expense of the Contractor. Test samples shall be submitted at least 60 days in advance of the time when the placing of the stone protection is expected to begin. Stone protection material shall not be delivered to the site of the work prior to approval of the test samples. The total overall weight of the sample of material proposed for quarry-run stone shall approximate 4.45 kN and representative pieces shall weigh not more than 445 N. If the protection stone is obtained from more than one source, samples of the proposed stone shall be submitted from each 1 source. The submission of samples will not be required if the material is obtained from a source approved by the Government from suitable tests and service records.

## 2.1.2 Quality

Suitable tests and service records will be used to determine the acceptability of the stone protection materials. If suitable test reports

and a service record that are satisfactory to the Contracting Officer are not available, as in the case of newly operated sources, the material shall be subjected to such tests as are necessary to determine its acceptability for use in the work. Tests to which the materials may be subjected include petrographic analysis, specific gravity, abrasion, absorption, wetting and drying, freezing and thawing, and such other tests as may be considered necessary to demonstrate to the satisfaction of the Contracting Officer that the materials are acceptable for use in the work. All tests shall be made by the Contractor. Tests and test values listed below are for job controls of quarry-run stone material being produced. Stone shall be durable and of a suitable quality to insure permanence in the structure and in the climate in which it is to be used. It shall be free from cracks, seams, and other defects that would tend to increase unduly its deterioration from natural causes. The inclusion of objectionable quantities of dust, sand, clay, and rock dust will not be permitted.

#### 2.1.2.1 Weight, Specific Gravity, and Absorption

The minimum weight per solid cubic foot calculated from the bulk specific gravity (saturated surface-dry) of the sample determined in accordance with the procedure in ASTM C 127 shall be 694 N. Bulk specific gravity shall be not less than 2.50, and maximum absorption shall not exceed 6 percent as determined in accordance with the procedures specified in ASTM C 127.

#### 2.1.2.2 Soundness (Magnesium Sulfate Test)

The loss of weight of stone after testing with five cycles of magnesium sulfate shall not exceed 35 percent. The tests will be in accordance with the procedures designated in ASTM C 88. The tests will be performed on 38 to 64 mm size aggregate.

#### 2.1.2.3 Resistance to Abrasions

Stone will be subjected to Los Angeles Abrasion Test (ASTM C 535) and shall show a loss in weight of not more than 45 percent after 500 revolutions.

### 2.2 GRADATION

Stone shall be free from overburden spoil, except dirt and fines accumulated from interledge layers or from blasting or loading operations up to 8 percent by weight of total sample tested passing the -inch square mesh sieve will be accepted.

#### RIPRAP GRADATION

Thickness (inches)	Maximum Weight (pounds)	Ave. Size (pounds)	Not More Than 20% Less Than (pounds)
12	150	30-50	20

### 3 EXECUTION

#### 3.1 FOUNDATION PREPARATION

Areas on which stone is to be placed shall be trimmed and dressed to conform to cross sections shown on the drawings within an allowable tolerance of plus or minus 51 mm from the theoretical slope lines and grades. Where such areas are below the allowable minus tolerance limit, they shall be brought to grade by filling with earth similar to the adjacent material and well compacted and no additional payment will be made for any material thus required. Immediately prior to placing the stone layer, the prepared base will be inspected by the Contracting Officer and no material shall be placed thereon until that area has been approved.

#### 3.2 PLACEMENT

The Contractor shall provide and set grade stakes at intervals not to exceed 7.62 m centers longitudinally, and at points of grade change. Placement shall produce a well keyed and stable mass of rocks with a finished surface corresponding to the lines and grades shown. These requirements include: Placement of stone to a full layer thickness in one operation in a manner to minimize segregation and avoid displacement of underlying materials.

Placement by means of a truck, clam, rock bucket, orange peel, or hydraulic excavator (Gradall) will be supplemented by hand placement to obtain a suitable product. All methods of placement shall be approved by the Contracting Officer and approval will be contingent on the Contractor's continued ability to provide an acceptable product. Stone shall be placed up the slope from the toe.

The Contractor shall provide for rearrangement loose stones and "chinking" of void spaces or hand placement as required for a stable mass.

The in place stone shall conform to the gradation specified.

Placement procedures that will not be permitted include: heavy or tracked equipment on the stone surface; dumping of stone at a higher elevation than the placement area and rolling into place; moving stone by drifting and manipulating by means of dozer, dragline bucket or other blade equipment; and final finishing of the stone with heavy plates or similar methods which would result in breakdown of the in place stone.

#### 3.3 SAMPLING AND TESTING

During construction, materials shall be sampled and tested by the Contractor as required to indicate conformance of the specified requirements.

## SECTION 02240

## LIME MODIFIED SUBGRADE

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 25	(1995a) Chemical Analysis of Limestone, Quicklime, and Hydrated Lime
ASTM C 50	(1994) Sampling, Inspection, Packing, and Marking of Lime and Limestone Products
ASTM D 977	(1991) Emulsified Asphalt
ASTM D 1556	(1990) Density of Soil In-Place by the Sand-Cone Method
ASTM D 1557	(1991) Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-Lb. (4.54-kg) Rammer and 18-In. (457-mm) Drop
ASTM D 2167	(1994) Density and Unit Weight of Soil In-Place by the Rubber Balloon Method
ASTM D 2922	(1991) Density of Soil and Soil-Aggregate In-Place by Nuclear Methods (Shallow Depth)
ASTM D 4643	(1993) Determination of Water (Moisture) Content of Soil by the Microwave Oven Method
ASTM E 548	(1994) Evaluating Laboratory Competence

## 1.2 DEFINITIONS

## 1.2.1 Lime-Modified Subgrade

Lime modified subgrade, as used herein, is a mixture of lime and in-place or select borrow material uniformly blended, wetted, and thoroughly compacted to produce a pavement course which meets all criteria as set forth in the plans and this specification.

## 1.2.2 Degree of Compaction

Degree of compaction required is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557 Method D, abbreviated hereinafter as percent laboratory maximum density.

### 1.3 GENERAL

The work specified herein consists of the construction of a lime-modified subgrade course. The work shall be performed in accordance with this specification and shall conform to the lines, grades, notes, and typical sections shown in the plans.

### 1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals with a "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL DESCRIPTIONS:

#### SD-09, Reports

##### Test Reports; FIO

Results of laboratory tests for quality control purposes shall be submitted to the Contracting Officer and approved prior to using the material.

Copies of field tests results shall be submitted within 24 hours after the tests are performed.

Calibration curves and related test results shall be submitted prior to using the device or equipment being calibrated.

Certified copies of manufacturer's test results indicating compliance of bituminous material with applicable specified requirements shall be submitted to the Contracting Officer not less than 30 days before the material is required in the work.

Sources of all materials shall be selected well in advance of the time that materials will be required in the work. Test results from samples shall be submitted for approval not less than 30 days before material is required for the work.

### 1.5 PLANT, EQUIPMENT, MACHINES, AND TOOLS

#### 1.5.1 General Requirements

Plant, equipment, machines, and tools used in the work shall be subject to approval and shall be maintained in satisfactory working condition at all times. Other compacting equipment may be used in lieu of that specified, where it can be demonstrated that the results are equivalent. The equipment shall be adequate and have the capability of producing the results specified. Protective equipment, apparel, and barriers shall be provided to protect the eyes, respiratory system, and the skin of workers exposed to contact with lime dust or slurry.

#### 1.5.2 Steel-Wheeled Rollers

Steel-wheeled rollers shall be the self-propelled type weighing not less than 10 metric tons, with a minimum weight of 136 kg per 25 mm-width of rear wheel. Wheels of the rollers shall be equipped with adjustable scrapers. The use of vibratory rollers is optional.



### 1.5.3 Pneumatic-Tired Rollers

Pneumatic-tired rollers shall have four or more tires, each loaded to a minimum of 13,600 kg and inflated to a minimum pressure of 1.035 MPa . The loading shall be equally distributed to all wheels, and the tires shall be uniformly inflated. Towing equipment shall also be pneumatic-tired.

### 1.5.4 Mechanical Spreader

Mechanical spreader shall be self-propelled or attached to a propelling unit capable of moving the spreader and material truck. The device shall be steerable and shall have variable speeds forward and reverse. The spreader and propelling unit shall be carried on tracks, rubber tires, or drum-type steel rollers that will not disturb the underlying material. The spreader shall contain a hopper, an adjustable screed, and outboard bumper rolls and be designed to have a uniform, steady flow of material from the hopper. The spreader shall be capable of laying material without segregation across the full width of the lane to a uniform thickness and to a uniform loose density so that when compacted, the layer or layers shall conform to thickness and grade requirements indicated. The Contracting Officer may require a demonstration of the spreader prior to approving use in performance of the work.

### 1.5.5 Sprinkling Equipment

Sprinkling equipment shall consist of tank trucks, pressure distributors, or other approved equipment designed to apply controlled quantities of water uniformly over variable widths of surface.

### 1.5.6 Tampers

Tampers shall be of an approved mechanical type, operated by either pneumatic pressure or internal combustion, and shall have sufficient weight and striking power to produce the compaction required.

### 1.5.7 Straightedge

The Contractor shall furnish and maintain at the site, in good condition, one 3.05 m straightedge for each bituminous paver, for use in the testing of the finished surface. Straightedge shall be made available for Government use. Straightedges shall be constructed of aluminum or other lightweight metal and shall have blades of box or box-girder cross section with flat bottom reinforced to insure rigidity and accuracy. Straightedges shall have handles to facilitate movement on pavement.

## 1.6 RATES OF MATERIALS APPLICATIONS

The rate of application of lime for the soil-lime mixture shall be at least 4 percent by dry weight of the nontreated soil. Bituminous material for curing shall be uniformly applied at the rate of 0.45 to 1.8 L per square meter. The exact bituminous material quantities, which may be varied to suit field conditions, will be determined by the Contracting Officer.

## 1.7 WEATHER LIMITATIONS

Lime shall not be applied when the atmospheric temperature is less than 4 degrees C . No lime shall be applied to soils that are frozen or contain

frost. If the temperature falls below 2 degrees C , completed lime-treated areas shall be protected against any detrimental effects of freezing.

## 2 PRODUCTS

### 2.1 MATERIALS:

#### 2.1.1 Lime

Lime shall be a standard brand of hydrated lime or pelletized quicklime and shall be of such gradation that 99-1/2 percent passes a 0.850 mm sieve and a minimum of 85 percent passes a 0.150 mm sieve. Combined calcium oxide and magnesium oxide shall be not less than 70 percent.

#### 2.1.2 Bituminous Material

Material shall be emulsified asphalt ASTM D 977, Type RS-1 or RS-2.

#### 2.1.3 Material to be Modified:

Material shall be free of deleterious substances such as sticks, debris, organic matter, and stones greater than 75 mm in any dimension.

#### 2.1.4 Water

Water shall be clean, fresh, and free from injurious amounts oil, acid, or other deleterious materials.

## 3 EXECUTION

### 3.1 CONSTRUCTION

#### 3.1.1 Preparation:

All roads and pavement areas to be lime modified shall be prepared to approximate subgrade elevations in accordance with Section 02225 EARTHWORK FOR ROADWAYS. Adequate drainage shall be provided during the entire construction period to prevent water from collecting or standing on the area or on pulverized, mixed, or partially mixed material. Line and grade stakes shall be provided as necessary for control. The area shall be cleaned of debris. The area shall be capable of the compaction specified for the soil-lime mixture. Debris and removed unsatisfactory in-place material shall be disposed of as specified. The entire area shall be graded to approximately conform to the lines, grades, and cross sections shown. Soft or yielding subgrade areas shall be made stable before construction is begun.

#### 3.1.2 Scarifying and Pulverizing of Soil

Prior to application of lime, the in place soil shall be scarified and pulverized as necessary with no stones or lumps larger than 63 mm in any dimension to a sufficient width and depth to obtain a uniform mixture of soil, lime, and water and to form a compacted subgrade conforming to the cross section indicated. Scarification shall be carefully controlled so that the layer beneath the layer to be treated is not disturbed.

### 3.1.3 Application of Lime

Pulverized material shall be shaped to approximately the cross section indicated. Lime shall be applied at the specified rate. Mechanical spreaders shall be used in applying bulk lime. Equipment used for spreading lime shall be approved type which will distribute the lime at controlled uniform rates. If lime is spread by hand, the bags shall be spotted so that when the bags are opened the lime will be dumped and spread uniformly on the area being processed. No equipment except that used in spreading and mixing shall pass over the freshly applied lime.

### 3.1.4 Initial Mixing

Immediately after the lime has been distributed, the lime and soil shall be mixed. Initial mixing shall be sufficient to alleviate any dusting or wetting of the lime that might occur in the event of wind or rainstorms. This may be accomplished several days in advance of the final water application and mixing.

### 3.1.5 Water Application and Final Mixing

Moisture content of the mixture shall be determined prior to final mixing and water shall be added as required. Moisture in the mixture following final mixing shall be between optimum and 3 percent above optimum. Water shall be incrementally incorporated and simultaneously intermixed into the soil. After the last portion of water has been added, mixing shall be continued until the water is uniformly distributed throughout the full depth of the mixture. Particular care shall be taken to ensure satisfactory moisture distribution along the edges of the section.

### 3.1.6 Compaction

Before compaction operations are started and as a continuation of the mixing operation, the mixture shall be thoroughly loosened and pulverized to the full depth. The soil lime mixture shall be reduced in size to meet the following requirements when tested dry by laboratory sieves: Min. passing 38 mm - 100 percent; Min. passing 6.3 mm sieve-60 percent. Compaction shall be started immediately after mixing is completed. During final compaction, the surface shall be moistened, if necessary, and shaped to the required lines, grades, and cross section.

Density of compacted mixture shall be at least 90 percent of maximum density. Rolling shall begin at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one-half the width of the roller. Alternate trips of the roller shall be slightly different lengths. The speed of the roller at all times shall be such that displacement of the mixture does not occur. Areas inaccessible to the rollers shall be compacted with mechanical tampers, and shall be shaped and finished by hand methods. Final compacted thickness of the subgrade shall be as indicated. No layer shall be in excess of 200 mm or less than 75 mm in compacted thickness.

### 3.1.7 Edges

Approved material shall be placed along the edges of the course in such quantity as will compact to the thickness of the course being constructed,

allowing at least a 300 mm width of the shoulder to be rolled and compacted simultaneously with the rolling and compacting of the subgrade.

#### 3.1.8 Finishing

The surface shall be finished to the grade and cross section shown. The surface shall be of uniform texture. Should the surface for any reason become rough, corrugated, uneven in texture, or traffic-marked prior to completion, such unsatisfactory portions shall be scarified, reworked, relaid, or replaced as directed. Should any portion of the course, when laid, become watersoaked for any reason, that portion shall be removed immediately, and the mix placed in a windrow and aerated until a moisture content within the limits specified is obtained, and then spread, shaped, and rolled as specified above.

#### 3.1.9 Thickness Control

Completed thickness of the subgrade course shall be not more than 13 mm below the thickness indicated. Where more than 13 mm deficient, such areas shall be corrected by scarifying, adding proper mixture, reblading, and recompacting as directed. The average of all thickness measurements taken for the job shall be within 6 mm of the thickness indicated.

#### 3.1.10 Construction Joints

At the end of each phase of construction, a straight transverse construction joint shall be formed by cutting back into the completed work to form a true vertical face free of loose or shattered material. Material along construction joints not properly compacted shall be removed and replaced with soil-lime mixture that is mixed, moistened, and compacted as specified.

### 3.2 CURING

Immediately after finishing the surface shall be protected against rapid drying by bituminous material curing. Emulsified asphalt bituminous material shall be uniformly applied at a rate of 0.45 to 1.8 L per square meter by means of a bituminous distributor at a temperature within the following ranges:

RS-1 .....	25-55C
RS-2 .....	45-70C

Areas inaccessible to or missed by the distributor shall be properly treated using the manually operated hose attachment. At the time the bituminous material is applied, the surface of the area shall be free of loose or foreign matter. When necessary, the area shall be sprinkled immediately before the bituminous material is applied.

### 3.3 PROTECTION

Completed portions of the subgrade may be opened immediately to light traffic provided the curing is not impaired. After the curing period, completed areas may be opened to all traffic, provided the course has hardened sufficiently to prevent marring or distorting of the surface by equipment or traffic. Heavy equipment shall not be permitted on the area during the curing period. Lime and water may be hauled over the completed area with pneumatic-tired equipment if approved. Finished portions of the

surface that are traveled on by equipment used in constructing an adjoining section shall be protected in a manner to prevent equipment from marring or damaging completed work.

### 3.4 MAINTENANCE

The subgrade shall be maintained in a satisfactory condition until the completed work is accepted. Maintenance shall include immediate repairs of any defects and shall be repeated as often as necessary to keep the area intact. Defects shall be corrected as specified herein.

### 3.5 DISPOSAL OF UNSATISFACTORY MATERIALS

Removed in-place materials that are unsuitable for stabilization, material that is removed for the required correction of defective areas, waste material, and debris shall be disposed of as directed.

### 3.6 SAMPLING AND TESTING

#### 3.6.1 General Requirements

Sampling and testing shall be the Contractor's responsibility and shall be performed by an approved commercial testing laboratory or by facilities furnished by the Contractor. Approval of testing facilities shall be based on compliance with ASTM E 548 and no work requiring testing shall be permitted until the facilities have been inspected and approved. The first inspection shall be at the expense of the Government. Cost incurred for any subsequent inspection required because of failure of the facilities to pass the first inspection will be charged to the Contractor. Three copies of the test results shall be furnished the Contracting Officer within 24 hours of conclusion of the test.

#### 3.6.2 Samples

Samples of lime shall be taken in accordance with ASTM C 50.

#### 3.6.3 Testing

Field in-place density shall be determined in accordance with ASTM D 1556, ASTM D 2167, or ASTM D 2922. If ASTM D 2922 is used, in place densities shall be checked by ASTM D 1556 at a frequency of one sand cone test for each 8 nuclear tests and not less than one sand cone test per lift.

The sand cone test shall be performed adjacent to the area where a nuclear density test was run to insure a proper correlation is established. Material from the sand cone location shall be tested to determine the laboratory maximum dry density as specified hereinafter. Moisture contents shall be determined in accordance with ASTM D 4643 or ASTM D 2216. If ASTM D 4643 is used, moisture contents shall be checked by ASTM D 2216 once per each ten microwave tests. At least one field density test and one moisture content test shall be performed for each 836 square meters of each layer of modified subgrade.

#### 3.6.4 Thickness

Completed thicknesses of the modified course shall be within 13 mm of the thickness indicated. Where the measured thickness of the modified course is

more than 13 mm deficient, such areas shall be corrected by scarifying, adding mixture of proper gradation, reblading, and recompacting as directed. Where the measured thickness of the modified course is more than 13 mm thicker than indicated, it shall be considered as conforming to the specified thickness requirement. Average job thickness shall be the average of all thickness measurements taken for the job, but shall be within 6 mm of the thickness indicated. Thickness of the modified course shall be measured at intervals in such a manner as to ensure one measurement for each 418 square meters of modified course. Measurements shall be made in 75 mm diameter test holes penetrating the modified course.

#### 3.6.5 Smoothness

The surface of the modified layer shall show no deviations in excess of 10 mm when tested with a 3.05 m straightedge. Deviations exceeding this amount shall be corrected by removing material and replacing with new material, or by reworking existing material and compacting, as directed. Measurements for deviation from grade and cross section shown shall be taken in successive positions parallel to the road centerline with a 3.05 m straightedge. Measurements shall also be taken perpendicular to the road centerline at 15 m intervals.

#### 3.6.6 Laboratory Density

The laboratory maximum dry density and optimum moisture content of the lime-soil mixture shall be determined from samples obtained at a selected sand cone test location. A minimum of one laboratory maximum density test shall be run each placement day or fraction thereof. Additional laboratory density tests shall be run each material change. Tests shall be conducted in accordance with ASTM D 1557, Method D.

#### 3.6.7 Chemical Analysis

Lime shall be tested for the specified chemical requirements in accordance with ASTM C 25.

## SECTION 02241

## AGGREGATE BASE COURSE

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 29	(1991a) Unit Weight and Voids in Aggregate
ASTM C 131	(1989) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1995a) Sieve Analysis of Fine and Coarse Aggregates
ASTM D 75	(1987; R 1992) Sampling Aggregates
ASTM D 422	(1963; R 1990) Particle-Size Analysis of Soils
ASTM D 1556	(1990) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu. m.))
ASTM D 2922	(1991) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 4253	(1991) Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
ASTM D 4318	(1993) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 4643	(1993) Determination of Water (Moisture) Content of Soil by the Microwave Oven Method
ASTM E 11	(1995) Wire-Cloth Sieves for Testing Purposes

## OKLAHOMA DEPARTMENT OF TRANSPORTATION (ODOT)

ODOT Standard Specifications for Highway Construction, Edition of 1988 with 1991 Supplement

TEXAS STATE DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION  
(TSDHPT)TSDHPT Standard Specifications for Construction of Highways, Streets and  
Bridges, 1982

## 1.2 DEFINITIONS

## 1.2.1 Aggregate Base

Aggregate base as used herein is well graded, durable aggregate uniformly moistened and mechanically stabilized by compaction.

## 1.2.2 Degree of Compaction

Degree of compaction is a percentage of the maximum laboratory dry density obtained by the test procedure presented in ASTM D 1557 or ASTM D 4253. ASTM D 1557 shall be used for soils containing 15 percent or more passing the no. 200 sieve (fines). ASTM D 4253 shall be used for soils containing 5 percent or less fines. The maximum laboratory dry density for soils containing between 5 and 15 percent fines shall be determined by the above procedure yielding the highest laboratory dry density. The percentage of material passing the no. 200 sieve shall be determined in accordance with ASTM D 4253. Degree of compaction shall be expressed as a percentage of the maximum laboratory dry density obtained by the appropriate procedure as defined above. Percentage of maximum laboratory dry density has been abbreviated hereinafter as percent laboratory maximum density.

## 1.3 GENERAL

The work specified herein consists of the construction of an aggregate base course. The work shall be performed in accordance with this specification and shall conform to the lines, grades, notes and typical sections shown in the plans. Sources of all materials shall be selected well in advance of the time that materials will be required in the work.

## 1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL DESCRIPTIONS:

SD-01 Data

Plant, Equipment, Machines, and Tools; FIO.

List of proposed equipment to be used in performance of construction work including descriptive data.

Sampling and Testing; FIO. Field Density; FIO.

Calibration curves and related test results prior to using the device or equipment being calibrated. Copies of field test results within 24 hours after the tests are performed. Certified copies of test results for approval not less than 30 days before material is required for the work.



## SD-18 Records

Coarse Aggregate; FIO.

A notification stating which type of coarse aggregate is to be used.

## 1.5 WEATHER LIMITATIONS

Base shall not be constructed when the atmospheric temperature is less than 2 degrees C . Base shall not be constructed on subgrades that are frozen or contain frost. If the temperature falls below 2 degrees C , completed areas shall be protected against any detrimental effects of freezing.

## 1.6 PLANT, EQUIPMENT, MACHINES, AND TOOLS

## 1.6.1 General Requirements

Plant, equipment, machines, and tools used in the work shall be subject to approval and shall be maintained in satisfactory working condition at all times. Other compacting equipment may be used in lieu of that specified, where it can be demonstrated that the results are equivalent. The equipment shall be adequate and have the capability of producing the results specified.

## 1.6.2 Steel-Wheeled Rollers

Steel-wheeled rollers shall be the self-propelled type weighing not less than 10 metric tons , with a minimum weight of 136 kg per 13 mm width of rear wheel. Wheels of the rollers shall be equipped with adjustable scrapers. The use of vibratory rollers is optional.

## 1.6.3 Pneumatic-Tired Rollers

Pneumatic-tired rollers shall have four or more tires, each loaded to a minimum of 30,000 pounds and inflated to a minimum pressure of 1.035 MPa . The loading shall be equally distributed to all wheels, and the tires shall be uniformly inflated. Towing equipment shall also be pneumatic-tired.

## 1.6.4 Mechanical Spreader

Mechanical spreader shall be self-propelled or attached to a propelling unit capable of moving the spreader and material truck. The device shall be steerable and shall have variable speeds forward and reverse. The spreader and propelling unit shall be carried on tracks, rubber tires, or drum-type steel rollers that will not disturb the underlying material. The spreader shall contain a hopper, an adjustable screed, and outboard bumper rolls and be designed to have a uniform, steady flow of material from the hopper. The spreader shall be capable of laying material without segregation across the full width of the lane to a uniform thickness and to a uniform loose density so that when compacted, the layer or layers shall conform to thickness and grade requirements indicated. The Contracting Officer may require a demonstration of the spreader prior to approving use in performance of the work.

#### 1.6.5 Sprinkling Equipment

Sprinkling equipment shall consist of tank trucks, pressure distributors, or other approved equipment designed to apply controlled quantities of water uniformly over variable widths of surface.

#### 1.6.6 Tamers

Tamers shall be of an approved mechanical type, operated by either pneumatic pressure or internal combustion, and shall have sufficient weight and striking power to produce the compaction required.

#### 1.6.7 Straightedge

The Contractor shall furnish and maintain at the site, in good condition, one 3.05 m straightedge for each bituminous paver, for use in the testing of the finished surface. Straightedge shall be made available for Government use. Straightedges shall be constructed of aluminum or other lightweight metal and shall have blades of box or box-girder cross section with flat bottom reinforced to insure rigidity and accuracy. Straightedges shall have handles to facilitate movement on pavement.

### 1.7 STOCKPILING MATERIALS

Materials, including approved material available from excavation and grading, shall be stockpiled in the manner and at locations designated. Before stockpiling of material, storage sites shall be cleared, and sloped to drain. Materials obtained from different sources shall be stockpiled separately.

### 1.8 SAMPLING AND TESTING

#### 1.8.1 General Requirements

Sampling and testing shall be performed by an approved commercial testing laboratory or by facilities furnished by the Contractor. No work requiring testing shall be permitted until the facilities have been inspected and approved. The first inspection shall be at the expense of the Government. Cost incurred for any subsequent inspection required because of failure of the facilities to pass the first inspection will be charged to the Contractor. Tests shall be performed in sufficient numbers and at the locations and times directed to insure that materials and compaction meet specified requirements. Copies of test results shall be furnished to the Contracting Officer within 24 hours of completion of tests.

#### 1.8.2 Test Results

Results shall verify that materials comply with this specification. When a material source is changed, the new material will be tested for compliance. When deficiencies are found, the initial analysis shall be repeated and the material already placed shall be retested to determine the extent of unacceptable material. All in-place unacceptable material shall be replaced or modified as directed by the Contracting Officer.

### 1.8.3 Sampling

Aggregate samples for laboratory tests shall be taken in accordance with ASTM D 75.

### 1.8.4 Sieve Analysis

Before starting work, at least one sample of material shall be tested in accordance with ASTM C 136 and ASTM D 422 on sieves conforming to ASTM E 11. After the initial test, a minimum of one analysis shall be performed for each 1000 metric tons of material placed, with a minimum of three analyses for each day's run until the course is completed.

### 1.8.5 Liquid Limit and Plasticity Index

One liquid limit and plasticity index shall be performed for each sieve analysis. Liquid limit and plasticity index shall be in accordance with ASTM D 4318. A minimum of one liquid limit and plastic limit test shall be run each day.

### 1.8.6 Laboratory Density

Tests shall provide a moisture-density relationship for the aggregate. Tests shall be conducted in accordance with ASTM D 1557, Method D.

### 1.8.7 Weight Per Cubic Meter of Slag

Weight per cubic meter of slag shall be determined in accordance with ASTM C 29.

### 1.8.8 Wear Tests

Wear tests shall be performed in accordance with ASTM C 131. One test shall be run per 2,500 square meters of completed base course. A minimum of one test per aggregate source shall be run.

### 1.8.9 Optimum Moisture and Laboratory Maximum Dry Density

The laboratory maximum dry density shall be determined from materials obtained at a sand cone test location using the appropriate procedure specified in Part 1 above. When ASTM D 1557 is used, the optimum moisture content shall be determined. A minimum of one laboratory maximum dry density test shall be run each placement day or fraction thereof. Additional laboratory maximum dry density tests shall be run for each material change.

## 2 PRODUCTS

### 2.1 MATERIALS

#### 2.1.1 Aggregates

Aggregates shall conform to ODOT Standard Specifications for Highway Construction, Section 703.01, Type A gradation.

Aggregates shall conform to TSDHPT Standard Specifications for Construction of Highways, Streets and Bridges, 1982, Item 249, Type A, Grade 1.

### 3 EXECUTION

#### 3.1 GENERAL REQUIREMENTS

When the base is constructed in more than one layer, the previously constructed layer shall be cleaned of loose and foreign matter by sweeping with power sweepers or power brooms, except that hand brooms may be used in areas where power cleaning is not practicable. Adequate drainage shall be provided during the entire period of construction to prevent water from collecting or standing on the working area. Line and grade stakes shall be provided as necessary for control. Grade stakes shall be in lines parallel to the centerline of the area under construction and suitably spaced for string lining.

#### 3.2 OPERATION OF AGGREGATE SOURCES

Aggregates shall be obtained from off-site sources.

#### 3.3 PREPARATION OF UNDERLYING COURSE

##### 3.3.1 General Requirements

Before constructing aggregate base course, the previously constructed underlying course shall be cleaned of foreign substances. Surface of underlying course shall meet the specified compaction and surface tolerances. Subgrade shall conform to Section 02240 LIME MODIFIED SUBGRADE and Section 02225 EARTHWORK FOR ROADWAYS. Ruts or soft, yielding spots that may appear in the underlying course, areas having inadequate compaction, and deviations of the surface from requirements specified shall be corrected. For cohesionless underlying materials containing sands, sand gravels, or any other cohesionless material in harmful quantities, the surface shall be mechanically stabilized with aggregate prior to placement of the aggregate course. Stabilization may be accomplished by mixing base course material into the underlying course and compacting by approved methods. Properly compacted material will be considered as part of the underlying course and shall meet all requirements for the underlying course. Finished underlying course shall not be disturbed by traffic or other operations and shall be maintained in a satisfactory condition until base course is placed.

##### 3.3.2 Grade Control

Underlying material shall be excavated to sufficient depth for the required base course thickness so that the finished base course with the subsequent surface course will meet the fixed grade. Finished and completed area shall conform to the lines, grades, cross section, and dimensions indicated.

#### 3.4 INSTALLATION

##### 3.4.1 Mixing and Placing

Materials shall be mixed by the stationary plant, traveling plant, or road mix method and placed in such a manner as to obtain uniformity of the aggregate base course material and at a uniform optimum water content for compaction. The Contractor shall make such adjustments in mixing or placing procedures or in equipment to obtain the true grades, to minimize segregation and degradation, to reduce or accelerate loss or increase of water, and to ensure a satisfactory base course.

### 3.4.2 Edges of Base Course

Approved material shall be placed along edges of aggregate base course in such quantities as will compact to thickness of the course being constructed, or to the thickness of each layer in a multiple layer course, allowing in each operation at least a 305 mm width of the shoulder to be rolled and compacted simultaneously with rolling and compacting of each layer of base course.

### 3.4.3 Compaction

Each layer of aggregate base course shall be compacted. Water content shall be maintained at optimum. Density of compacted mixture shall be at least 100 percent of laboratory maximum density. Rolling shall begin at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one-half the width of the roller. Alternate trips of the roller shall be slightly different lengths. Speed of the roller shall be such that displacement of the aggregate does not occur. Areas inaccessible to the rollers shall be compacted with mechanical tampers, and shall be shaped and finished by hand methods.

### 3.4.4 Layer Thickness

Compacted thickness of the aggregate course shall be as indicated. No layer shall be in excess of 200 mm nor less than 75 mm in compacted thickness.

### 3.4.5 Finishing

The surface of the top layer shall be finished to grade and cross section shown. Finished surface shall be of uniform texture. Light blading during compaction may be necessary for the finished surface to conform to the lines, grades, and cross sections. Should the surface for any reason become rough, corrugated, uneven in texture, or traffic marked prior to completion, such unsatisfactory portion shall be scarified, reworked, recompacted, or replaced as directed.

#### 3.4.5.1 Smoothness

Surface of each layer shall show no deviations in excess of 9 mm when tested with the 3.05-meter straightedge. Deviations exceeding this amount shall be corrected by removing material and replacing with new material, or by reworking existing material and compacting, as directed.

#### 3.4.5.2 Thickness Control

Compacted thickness of the base course shall be within 13 mm of the thickness indicated. Where the measured thickness is more than 13 mm deficient, such areas shall be corrected by scarifying, adding new material of proper gradation, reblading, and recompacting as directed. Where the measured thickness is more than 13 mm thicker than indicated, the course shall be considered as conforming to the specified thickness requirements. Average job thickness shall be the average of all thickness measurements taken for the job, but shall be within 7 mm of the thickness indicated.

### 3.5 FIELD QUALITY CONTROL

#### 3.5.1 Field Density

A sufficient quantity of material shall be obtained from the sand cone test location to determine the maximum laboratory dry density, gradation, liquid limit, and plastic limit. A gradation test shall be run on the sample prior to determining the maximum laboratory dry density. A portion of the sampled material passing the no. 40 sieve shall be tested to determine the liquid limit and plasticity index. Additional tests shall be run for each material change.

#### 3.5.2 Field Density and Moisture Content

Field in-place density shall be determined in accordance with ASTM D 1556 \ or ASTM D 2922. If ASTM D 2922 is used, in-place densities shall be checked by ASTM D 1556 at least once per each 8 nuclear density tests and at least once per each lift placed. The sand cone test shall be performed adjacent to the location where a nuclear density test was taken to ensure a proper correlation is established between the two methods. Moisture contents shall be determined in accordance with ASTM D 4643 or ASTM D 2216. If ASTM D 4643 is used, moisture contents shall be checked by ASTM D 2216 once per each ten microwave tests. The laboratory tests specified in Part 1 of this section shall be run on materials obtained from a sand cone test sample location. At least one field density and one moisture content test shall be performed for each 836 square meters of each layer of stabilized aggregate base material placed.

#### 3.5.3 Smoothness

Measurements for deviation from grade and cross section shown shall be taken in successive positions parallel to the road centerline with a 3 m straightedge. Measurements shall also be taken perpendicular to the road centerline at 15 meter intervals.

#### 3.5.4 Thickness

Thickness of the base course shall be measured at intervals in such a manner as to ensure one measurement for each 836 square meters of base course. Measurements shall be made in 75 mm diameter test holes penetrating the base course.

### 3.6 TRAFFIC

Completed portions of the area may be opened to traffic, provided there is no marring or distorting of the surface by the traffic. Heavy equipment shall not be permitted except when necessary to construction, and then the area shall be protected against marring or damage to the completed work.

### 3.7 MAINTENANCE

The aggregate base course shall be maintained in a satisfactory condition until accepted. Maintenance shall include immediate repairs to any defects and shall be repeated as often as necessary to keep the area intact.

### 3.8 DISPOSAL OF UNSATISFACTORY MATERIALS

Removed in-place materials that are unsuitable for the base course material that is removed for the required correction of defective areas, and waste material and debris shall be disposed of off site at the Contractor's responsibility.

## SECTION 02285

## SOIL TREATMENT FOR SUBTERRANEAN TERMITE CONTROL

## 1 GENERAL

## 1.1 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-01 Data

Qualifications; GA.

Qualifications of the pesticide applicator.

## SD-06 Instructions

Pesticides; FIO.

Manufacturer's label and Material Safety Data Sheet (MSDS) for pesticides proposed for use.

## 1.2 QUALIFICATIONS OF PESTICIDE APPLICATORS

The pesticide applicator's principal business shall be pest control and the pesticide applicator shall be State certified in the U.S. Environmental Protection Agency (EPA) pesticide applicator category which includes structural pest control, and certified in the State.

## 1.3 DELIVERY, STORAGE, AND HANDLING

Pesticides shall be delivered to the project site in sealed and labeled containers in good condition as supplied by the manufacturer or formulator. Pesticides shall be stored, handled, and used in accordance with manufacturer's labels. Labels shall bear evidence of registration under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), as amended.

## 1.4 SAFETY REQUIREMENTS

The Contractor shall formulate, treat, and dispose of termiticides and their containers in accordance with label directions. Water for formulating shall only come from sites designated by the Contracting Officer, and filling hose shall be fitted with a backflow preventer meeting local plumbing codes or standards. Overflow shall be prevented during the filling operation. Pesticides and related materials shall be kept under lock and key when unattended. Proper protective clothing and equipment shall be worn and used during all phases of termiticide application.

## 1.5 WARRANTY

The Contractor shall provide a 3-year written warranty against infestations or reinfestations by subterranean termites of the buildings or building additions constructed under this contract. Warranty shall include annual



inspections of the buildings. If live subterranean termite infestation or subterranean termite damage is discovered during the warranty period, and the soil and building conditions have not been altered in the interim, the Contractor shall:

- a. Re-treat the soil and perform other treatment as may be necessary for elimination of subterranean termite infestation;
- b. Repair damage caused by termite infestation; and
- c. Reinspect the building approximately 180 days after the retreatment.

## 2 PRODUCTS

### 2.1 MATERIALS

Termiticides shall be currently registered by the EPA.

## 3 EXECUTION

### 3.1 VERIFICATION OF CONDITIONS

At the time of application, the soil moisture content shall be sufficiently low to allow uniform distribution of the treatment solution throughout the soil. Applications shall not be made during or immediately following heavy rains or when conditions may cause runoff and create an environmental hazard.

### 3.2 APPLICATION

#### 3.2.1 Treatment of New Structures

The Contractor shall establish complete and unbroken vertical and/or horizontal (as necessary) soil poison barriers between the soil and all portions of the intended structure which may allow termite access to wood and wood related products. Application shall not be made to areas intended for use as a plenum air space. Surface treatments shall not be made for areas to serve as crawl spaces. Termiticide shall be applied as a coarse spray and provide uniform distribution unto the soil surface. Treatment shall be applied prior to placement of a vapor barrier or waterproof membrane and at least 12 hours prior to concrete placement.

Where treated soil or fill material is not to be covered with a vapor barrier or waterproof membrane, adequate precautions shall be taken to prevent its disturbance. Soil or fill material disturbed after treatment shall be re-treated as specified above before placement of slabs or other covering structures. Treatment of the soil on the exterior sides of foundation walls, grade beams, and similar structures shall be coordinated with final grading and planting operations so as to avoid disturbance of the treated barriers. Manufacturer's warnings and precautions shall be observed in the handling and use of such materials. Care shall be taken to prevent these chemicals from entering water supply systems, potable water supplies, or aquifers; and that they do not endanger plants or animals. The Contracting Officer shall be notified at least 48 hours prior to beginning of treatment and formulating, mixing, and application shall be performed in the presence of the Contracting Officer's representative.

### 3.2.2 Rates and Methods of Application

Rates and methods of application shall be in accordance with the manufacturer's instructions on the pesticide label. Maximum application or dosage rates shall be used. If the pesticide contains less than the amount of active ingredient specified on the label, work shall be repeated with pesticides conforming to this specification.

### 3.3 DISPOSAL

The Contractor shall dispose of residual pesticides and containers off Government property in accordance with label instructions and EPA criteria.

## SECTION 02383

## DRILLED FOUNDATION PIERS

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 615	(1995b) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A 616	(1995b) Rail-Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A 617	(1995b) Axle-Steel Deformed and Plain Bars for Concrete Reinforcement

## 1.2 CONTRACTOR QUALIFICATIONS

The work shall be performed by a Contractor specializing in the specified foundation system and having experience installing the specified foundation system under similar subsurface conditions and shall furnish evidence that he has been engaged in the successful installation of drilled foundation piers for at least 4 years.

## 1.3 SUBSURFACE DATA

Subsurface data logs are shown on the drawings. The subsurface investigation report is available for examination at the Tulsa District Office, Corps of Engineers.

## 1.4 SURVEYS

Lines and levels shall be established and pier centerline locations staked and maintained by a registered surveyor or engineer provided by the Contractor.

## 1.5 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

SD-04 Drawings

Reinforcing Steel; FIO.

Shop drawings shall be submitted for reinforcing steel.

## SD-13 Certifications

Contractor Qualifications; FIO. Survey Notes; FIO.

Copies of certified survey notes and certification of Contractor Qualifications shall be submitted to the Contracting Officer.

## SD-18 Records

Drilled Foundation Piers; FIO.

The Contractor shall furnish records for each pier, showing shaft and bell diameters, depths of test holes, top and bottom elevations, bearing strata description, casing description, water conditions, concrete strength, concrete volume rock elevations, dates of excavation and concrete placement, and other pertinent information. Records shall be submitted on forms as provided in SECTION 01440: CONTRACTOR QUALITY CONTROL. Upon completion of work, the Contractor shall provide a record of centerline locations based on the survey of the registered surveyor or engineer provided by the Contractor. In addition, corrective measures and construction changes shall be similarly recorded. All records shall be delivered to the Contracting Officer.

## 1.6 TOLERANCES

- a. Cross sections of shafts and bells shall not be less than dimensions indicated.
- b. The maximum allowable deviation for pier top location shall be 75 mm from centerline locations.
- c. The maximum allowable deviation of pier plumbness shall be 38 mm inches for the top 3 m and 7 mm in 3 m for the remaining depth.
- d. The maximum allowable inclination deviation for batter piers shall be 5 percent of length from specified inclination.
- e. The top of concrete placed shall be plus or minus 75 mm from the elevation shown.

## 1.7 SAFETY REQUIREMENTS

## 1.7.1 Life Line

Each person entering a drilled pier excavation shall be provided with a life line rigged so that the person can be immediately hoisted out of the excavation in an emergency. The life line shall be suitable for instant rescue, securely fastened to a shoulder harness, and separated from any line used to remove excavated materials. No person shall be lowered into a drilled pier excavation prior to casing the shaft through the overburden.

## 1.7.2 Ventilation

Drilled pier excavations shall be provided with a ventilating device of sufficient capacity to assure a safe atmosphere before workmen and inspectors are permitted to enter the excavation.

## 1.8 MEASUREMENT AND PAYMENT

Drilled foundation piers shall be measured by the linear meter for depths actually drilled in conformance to the specification requirements. The length of drilled piers shall be measured from the authorized bottom of the bells up to the bottom of the grade beam, slab, or pier cap, or up to the bottom of any formed portion of the pier above grade, as applicable. Payment for drilled foundation piers will be made at the applicable contract unit price per linear meter for the respective diameter pier listed in the BIDDING SCHEDULE. This payment shall constitute full compensation for all plant, labor, materials, and all costs necessary for drilling, casing, and furnishing and placing steel and concrete, complete, except bellling of piers. Costs of labor and materials associated with bellling piers shall not be included in the linear meter price, but shall be included in the applicable structure listed in the BIDDING SCHEDULE to which the bellling pertains.

## 2 - PRODUCTS

### 2.1 CONCRETE

Concrete shall conform to the requirements of Section 03300 as modified herein. Concrete strength shall be 25 Mpa at 28 days. Slump shall be from 125 to 175 mm .

### 2.2 COARSE AGGREGATE

Maximum size of coarse aggregate shall be 19 mm .

### 2.3 REINFORCING STEEL

Reinforcing steel shall conform to ASTM A 615, ASTM A 616, or ASTM A 617, Grade 420 . Steel shall be tied into cages and inserted securely in the piers in the position and alignment as shown prior to concrete placement.

## 3 EXECUTION

### 3.1 EQUIPMENT

Pier drilling equipment shall have sufficient torque capacity and downward force capacity for the site conditions.

### 3.2 INSTALLATION

#### 3.2.1 Excavation

Pier shafts and bells shall be excavated to depths, dimensions, and shapes shown. Bottoms of bells or shafts shall be cleaned of loose or soft material and leveled. Excavated material shall be disposed of in accordance with Section 02221.

#### 3.2.2 Temporary Casing

In drilling piers, the surrounding soil and the earth walls shall be protected against cave-ins, displacement of the surrounding earth, and retention of ground water by means of temporary steel casings. Casings

shall have outside diameters not less than indicated shaft sizes and shall be a minimum of 7 mm thick. Temporary steel casings shall be withdrawn as the concrete is being placed, maintaining sufficient head of concrete within the casing to prevent reduction in the diameter of the drilled shaft due to earth or hydrostatic pressure on the fresh concrete and to prevent extraneous material from falling in from the sides and mixing with concrete. Casings may be jerked upward a maximum of 100 mm to break the bottom seal but thereafter removal shall be with a smooth, continuous motion. The inside of steel casings shall be thoroughly cleaned and oiled before reuse. A temporary casing shall be placed from the pier top to the ground surface until the concrete has set if the elevation of the top of the pier is below the ground surface.

### 3.2.3 Placement

#### 3.2.3.1 General

Concrete shall be continuously placed within 3 hours after the completion of excavation. Concrete shall be placed by methods that insure against segregation and dislodging of excavation sidewalls and shall completely fill the shaft. Concrete shall be placed by pumping or drop chutes. Concrete shall be brought to a true level surface inside the shaft and a full width cross key formed or dowels installed should it become necessary to interrupt placing concrete in any pier. Prior to placing additional concrete, joint surfaces shall be cleaned of laitance and shall be slush grouted using one-to-one portland cement/sand mixture. Concrete shall be vibrated for the upper 1500 mm of the pier. Water that flows into the excavations shall be continuously removed and all water shall be removed from the excavation bottom, to the extent possible, prior to concrete placement. The maximum permissible depth of water will be 50 mm at the beginning of the concrete placement.

#### 3.2.3.2 Underwater Placement

In the event of a water condition that makes it impossible or impractical to dewater the excavation, concrete shall be placed under water by pumping after water movement has stabilized. The pump pipe for depositing concrete in the drilled shaft shall have a minimum inside diameter of 100 mm and shall be watertight. The discharge end of the pump pipe shall be constructed so that it is watertight against intrusion from outside and so that it will readily discharge concrete. The pump pipe shall be kept full of concrete until work is completed.

### 3.3 PROTECTION

Protection shall be provided around top of all excavations to prevent debris from being dislodged into the excavation and concrete.

### 3.4 QUALITY CONTROL

#### 3.4.1 Contractor Supervision

The Contractor shall provide for the supervision of all phases of drilled pier construction. Each drilled pier excavation shall be checked by the Contractor for its depth, water removal, cleanup, workmanship, and for all tolerance requirements before any concrete is placed.

#### 3.4.2 Government Inspection

The Contracting Officer will inspect each drilled pier excavation. Concrete shall not be placed until the excavation has been approved by the Contraction Officer. The Contractor shall furnish the Contracting Officer all necessary equipment and support personnel required for proper inspection of drilled pier excavations.

## SECTION 02500

## PAVEMENT REMOVAL

## 1 GENERAL (NOT APPLICABLE)

## 2 PRODUCTS (NOT APPLICABLE)

## 3 EXECUTION

## 3.1 BITUMINOUS PAVEMENT

Existing bituminous pavement shall be completely removed as necessary for construction of new paving, transitional areas and for other construction operations requiring pavement removal. Edges of flexible pavement to be matched to new paving shall be cut smooth with pneumatic spades. All bituminous materials, binder, and aggregate shall be thoroughly removed. Any damage occurring to surfaces or pavements to remain, due to the Contractor's operations shall be repaired as directed at the expense of the Contractor. Removal shall be by approved methods and the materials removed shall be disposed of in the designated waste areas.

## 3.2 CONCRETE PAVEMENT

Existing concrete pavement shall be removed in the areas shown on the drawings. Pavement shall be removed in such a manner that no damage will occur in adjacent slabs. All concrete pavement to be removed where the limits of removal are not at existing joints, shall be scored to a depth of not less than 75 mm with a concrete saw or other similar equipment. Scoring shall be done in a straight line and shall be parallel to the existing joints where possible. Care shall be taken not to damage adjacent slabs. If adjacent slabs are damaged during removal operations as determined by the Contracting Officer, the damaged portion shall be removed and replaced at the Contractor's expense and in a manner as directed by the Contracting Officer. If cracks or overbreakage into adjacent concrete slabs occur during removal operations, the area within the scoring line shall be widened sufficiently to remove cracks or overbreakage, but if cracks or overbreakage fall within one foot of the next adjacent joint, the remainder of the slab adjacent to that joint shall be removed. During removal operations and after concrete has been removed, the Contractor shall exercise all precautions necessary to keep water from entering the subgrade. If water should enter the excavation, the Contractor shall remove the water by pumping and shall allow adequate time for the subgrade to dry, as determined by the Contracting Officer. Any slab or portion of slabs damaged due to negligence on the part of the contractor shall be removed and replaced at his own expense. Pavement which is removed shall be disposed of in the designated waste areas.



## SECTION 02511

## CONCRETE SIDEWALKS AND CURBS AND GUTTERS

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS  
(AASHTO)

AASHTO M 182 (1991) Burlap Cloth Made from Jute or Kenaf

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 185 (1990a) Steel Welded Wire Fabric, Plain, for Concrete Reinforcement

ASTM A 615 (1990) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

ASTM A 616 (1990) Rail-Steel Deformed and Plain Bars for Concrete Reinforcement

ASTM A 617 (1990) Axle-Steel Deformed and Plain Bars for Concrete Reinforcement

ASTM C 31 (1991) Making and Curing Concrete Test Specimens in the Field

ASTM C 143 (1990a) Slump of Hydraulic Cement Concrete

ASTM C 171 (1991) Sheet Materials for Curing Concrete

ASTM C 172 (1990) Sampling Freshly Mixed Concrete

ASTM C 173 (1978) Air Content of Freshly Mixed Concrete by the Volumetric Method

ASTM C 231 (1991b) Air Content of Freshly Mixed Concrete by the Pressure Method

ASTM C 309 (1991) Liquid Membrane-Forming Compounds for Curing Concrete

ASTM D 1751 (1983; R 1991) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)

ASTM D 1752 (1984; R 1992) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

ASTM D 3405 (1994) Joint Sealants, Hot-Applied, for Concrete and Asphalt Pavements

CORPS OF ENGINEERS (COE)

COE CRD-C 527 (1988) Standard Specification for Joint Sealants, Cold-Applied, Non-Jet-Fuel-Resistant, for Rigid and Flexible Pavements

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

### SD-09 Reports

Field Quality Control; FIO.

Copies of all test reports within 24 hours of completion of the test.

### SD-18 Records

Concrete; FIO.

Copies of certified delivery tickets for all concrete used in the construction.

## 1.3 WEATHER LIMITATIONS

### 1.3.1 Placing During Cold Weather

Concrete placement shall be discontinued when the air temperature reaches 5 degrees C and is falling. Placement may begin when the air temperature reaches 2 degrees C and is rising. Provisions shall be made to protect the concrete from freezing during the specified curing period. If necessary to place concrete when the temperature of the air, aggregates, or water is below 2 degrees C, placement shall be approved in writing. Approval shall be contingent upon full conformance with the following provisions. The underlying material shall be prepared and protected so that it is entirely free of frost when the concrete is deposited. Mixing water and aggregates shall be heated as necessary to result in the temperature of the in-place concrete being between 10 and 30 degrees C. Methods and equipment for heating shall be approved. The aggregates shall be free of ice, snow, and frozen lumps before entering the mixer. Covering and other means shall be provided for maintaining the concrete at a temperature of at least 10 degrees C for not less than 72 hours after placing, and at a temperature above freezing for the remainder of the curing period.

### 1.3.2 Placing During Warm Weather

The temperature of the concrete as placed shall not exceed 30 degrees C except where an approved retarder is used. The mixing water and/or aggregates shall be cooled, if necessary, to maintain a satisfactory placing temperature. In no case shall the placing temperature exceed 35 degrees C.

## 1.4 PLANT, EQUIPMENT, MACHINES, AND TOOLS

### 1.4.1 General Requirements

Plant, equipment, machines, and tools used in the work shall be subject to approval and shall be maintained in a satisfactory working condition at all times. The equipment shall have the capability of producing the required product, meeting grade controls, thickness control and smoothness requirements as specified. Use of the equipment shall be discontinued if it produces unsatisfactory results. The Contracting Officer shall have access at all times to the plant and equipment to ensure proper operation and compliance with specifications.

### 1.4.2 Slip Form Equipment

Slip form paver or curb forming machine, will be approved based on trial use on the job and shall be self-propelled, automatically controlled, crawler mounted, and capable of spreading, consolidating, and shaping the plastic concrete to the desired cross section in one pass.

## 2 PRODUCTS

### 2.1 CONCRETE

Concrete shall conform to the applicable requirements of Section 03300 except as otherwise specified. Concrete shall have a minimum compressive strength of 24 MPa at 28 days. Maximum size of aggregate shall be 37.5 mm.

#### 2.1.1 Air Content

Mixtures shall have air content by volume of concrete of 5 to 7 percent, based on measurements made immediately after discharge from the mixer.

#### 2.1.2 Slump

The concrete slump shall be 50 mm plus or minus 25 mm for hand-placed concrete or 25 mm plus or minus 10 mm for slipformed concrete when determined in accordance with ASTM C 143.

#### 2.1.3 Reinforcement Steel

Reinforcement bars shall conform to ASTM A 615, ASTM A 616, or ASTM A 617. Wire mesh reinforcement shall conform to ASTM A 185.

### 2.2 CONCRETE CURING MATERIALS

#### 2.2.1 Impervious Sheet Materials

Impervious sheet materials shall conform to ASTM C 171, type optional, except that polyethylene film, if used, shall be white opaque.

### 2.2.2 Burlap

Burlap shall conform to AASHTO M 182.

### 2.2.3 White Pigmented Membrane-Forming Curing Compound

White pigmented membrane-forming curing compound shall conform to ASTM C 309, Type 2.

## 2.3 CONCRETE PROTECTION MATERIALS

Concrete protection materials shall be a linseed oil mixture of equal parts, by volume, of linseed oil and either mineral spirits, naphtha, or turpentine. At the option of the contractor, commercially prepared linseed oil mixtures, formulated specifically for application to concrete to provide protection against the action of deicing chemicals may be used, except that emulsified mixtures are not acceptable.

## 2.4 JOINT FILLER STRIPS

### 2.4.1 Contraction Joint Filler for Curb and Gutter

Contraction joint filler for curb and gutter shall consist of hard-pressed fiberboard.

### 2.4.2 Expansion Joint Filler, Premolded

Expansion joint filler, premolded, shall conform to ASTM D 1751 or ASTM D 1752, 9.5 mm (3/8 inch) thick, unless otherwise indicated.

## 2.5 JOINT SEALANTS

### 2.5.1 Joint Sealant, Cold-Applied

Joint sealant, cold-applied shall conform to COE CRD-C 527.

### 2.5.2 Joint Sealant, Hot-Poured

Joint sealant, hot-poured shall conform to ASTM D 3405.

## 2.6 FORM WORK

Form work shall be designed and constructed to insure that the finished concrete will conform accurately to the indicated dimensions, lines, and elevations, and within the tolerances specified. Forms shall be of wood or steel, straight, of sufficient strength to resist springing during depositing and consolidating concrete. Wood forms shall be surfaced plank, 50 mm nominal thickness, straight and free from warp, twist, loose knots, splits or other defects. Wood forms shall have a nominal length of 3 m. Radius bends may be formed with 19 mm boards, laminated to the required thickness. Steel forms shall be channel-formed sections with a flat top surface and with welded braces at each end and at not less than two intermediate points. Ends of steel forms shall be interlocking and self-aligning. Steel forms shall include flexible forms for radius forming, corner forms, form spreaders, and fillers. Steel forms shall have a nominal length of 3 m with a minimum of two welded stake pockets per form. Stake

pins shall be solid steel rods with chamfered heads and pointed tips designed for use with steel forms.

#### 2.6.1 Sidewalk Forms

Sidewalk forms shall be of a height equal to the full depth of the finished sidewalk.

#### 2.6.2 Curb and Gutter Forms

Curb and gutter outside forms shall have a height equal to the full depth of the curb or gutter. The inside form of curb shall have batter as indicated and shall be securely fastened to and supported by the outside form. Rigid forms shall be provided for curb returns, except that benders or thin plank forms may be used for curb or curb returns with a radius of 3 m or more, where grade changes occur in the return, or where the central angle is such that a rigid form with a central angle of 90 degrees cannot be used. Back forms for curb returns may be made of 38 mm benders, for the full height of the curb, cleated together.

### 3 EXECUTION

#### 3.1 SUBGRADE PREPARATION

The subgrade shall be constructed to the specified grade and cross section prior to concrete placement.

##### 3.1.1 Sidewalk Subgrade

The subgrade shall be tested for grade and cross section with a template extending the full width of the sidewalk and supported between side forms.

##### 3.1.2 Curb and Gutter Subgrade

The subgrade shall be tested for grade and cross section by means of a template extending the full width of the curb and gutter. The subgrade shall be of materials equal in bearing quality to the subgrade under the adjacent pavement.

##### 3.1.3 Maintenance of Subgrade

The subgrade shall be maintained in a smooth, compacted condition in conformity with the required section and established grade until the concrete is placed. The subgrade shall be in a moist condition when concrete is placed. The subgrade shall be prepared and protected so as to produce a subgrade free from frost when the concrete is deposited.

#### 3.2 FORM SETTING

Forms shall be carefully set to the indicated alignment, grade and dimensions. Forms shall be held rigidly in place by a minimum of three stakes per form placed at intervals not to exceed 1.2 meters. Corners, deep sections, and radius bends shall have additional stakes and braces, as required. Clamps, spreaders, and braces shall be used where required to insure rigidity in the forms. Forms shall be removed without injuring the concrete. Bars or heavy tools shall not be used against the concrete in removing the forms. Any concrete found defective after form removal shall

be promptly and satisfactorily repaired. Forms shall be cleaned and coated with form oil each time before concrete is placed. Wood forms may, instead, be thoroughly wetted with water before concrete is placed, except that with probable freezing temperatures, oiling is mandatory.

### 3.2.1 Sidewalks

Forms for sidewalks shall be set with the upper edge true to line and grade with an allowable tolerance of 3 mm in any 3 m long section. After forms are set, grade and alignment shall be checked with a 3.05 m straightedge. Forms shall have a transverse slope of 20 millimeters per meter with the low side adjacent to the roadway. Side forms shall not be removed for 12 hours after finishing has been completed.

### 3.2.2 Curbs and Gutters

The forms of the front of the curb shall be removed not less than 2 hours nor more than 6 hours after the concrete has been placed. Forms back of curb shall remain in place until the face and top of the curb have been finished as specified for concrete finishing. Gutter forms shall not be removed while the concrete is sufficiently plastic to slump in any direction.

## 3.3 SIDEWALK CONCRETE PLACEMENT AND FINISHING

### 3.3.1 Formed Sidewalks

Concrete shall be placed in the forms in one layer of such thickness that when consolidated and finished the sidewalks will be of the thickness indicated. After concrete has been placed in the forms, a strike-off guided by side forms shall be used to bring the surface to proper section to be compacted. The concrete shall be consolidated with an approved vibrator, and the surface shall be finished to grade with a wood float, bull float, or darby, edged and broom finished.

### 3.3.2 Concrete Finishing

After straightedging, when most of the water sheen has disappeared, and just before the concrete hardens, the surface shall be finished to a smooth and uniformly fine granular or sandy texture free of waves, irregularities, or tool marks. A scored surface shall be produced by brooming with a fiber-bristle brush in a direction transverse to that of the traffic.

### 3.3.3 Edge and Joint Finishing

All slab edges, including those at formed joints, shall be finished carefully with an edger having a radius of 3 mm. Transverse joint shall be edged before brooming, and the brooming shall eliminate the flat surface left by the surface face of the edger. Corners and edges which have crumbled and areas which lack sufficient mortar for proper finishing shall be cleaned and filled solidly with a properly proportioned mortar mixture and then finished.

### 3.3.4 Surface and Thickness Tolerances

Finished surfaces shall not vary more than 7.9 mm from the testing edge of a 3.05 m straightedge. Permissible deficiency in section thickness will be up to 6.4 mm.

## 3.4 CURB AND GUTTER CONCRETE PLACEMENT AND FINISHING

### 3.4.1 Formed Curb and Gutter

Concrete shall be placed to the section required in a single lift. Consolidation shall be achieved by using approved mechanical vibrators.

### 3.4.2 Concrete Finishing

Exposed surfaces shall be floated and finished with a smooth wood float until true to grade and section and uniform in texture. Floated surfaces shall then be brushed with a fine-hair brush with longitudinal strokes. The edges of the gutter and top of the curb shall be rounded with an edging tool to a radius of 13 mm. Immediately after removing the front curb form, the face of the curb shall be rubbed with a wood or concrete rubbing block and water until blemishes, form marks, and tool marks have been removed. The front curb surface, while still wet, shall be brushed in the same manner as the gutter and curb top. The top surface of gutter and entrance shall be finished to grade with a wood float.

### 3.4.3 Joint Finishing

Curb edges at formed joints shall be finished as indicated.

### 3.4.4 Surface and Thickness Tolerances

Finished surfaces shall not vary more than 6.4 mm from the testing edge of a 3.05 m straightedge. Permissible deficiency in section thickness will be up to 6.4 mm.

## 3.5 SIDEWALK JOINTS

Sidewalk joints shall be constructed to divide the surface into rectangular areas. Transverse contraction joints shall be spaced at a distance equal to the sidewalk width or 1.5 m on centers, whichever is less, and shall be continuous across the slab. Longitudinal contraction joints shall be constructed along the centerline of all sidewalks 3 m or more in width. Transverse expansion joints shall be installed at sidewalk returns and opposite expansion joints in adjoining curbs. Where the sidewalk is not in contact with the curb, transverse expansion joints shall be installed as indicated. Expansion joints shall be formed about structures and features which project through or into the sidewalk pavement, using joint filler of the type, thickness, and width indicated.

### 3.5.1 Contraction Joints

The contraction joints shall be formed in the fresh concrete by cutting a groove in the top portion of the slab to a depth of at least one-fourth of the sidewalk slab thickness, using a jointer to cut the groove, or by sawing a groove in the hardened concrete with a power-driven saw, unless otherwise approved. Sawed joints shall be constructed by sawing a groove in the

concrete with a 3 mm (1/8-inch) blade to the depth indicated. An ample supply of saw blades shall be available on the job before concrete placement is started, and at least one standby sawing unit in good working order shall be available at the jobsite at all times during the sawing operations.

### 3.5.2 Expansion Joints

Expansion joints shall be formed with 9.5 mm joint filler strips. Joint filler shall be placed with top edge 6 mm below the surface and shall be held in place with steel pins or other devices to prevent warping of the filler during floating and finishing. Immediately after finishing operations are completed, joint edges shall be rounded with an edging tool having a radius of 3 mm, and concrete over the joint filler shall be removed. At the end of the curing period, expansion joints shall be carefully cleaned and filled with joint sealer.

The joint opening shall be thoroughly cleaned before the sealing material is placed. Sealing shall be done so that the material will not be spilled on exposed surfaces of the concrete. Concrete at the joint shall be surface dry and atmospheric and concrete temperatures shall be above 10 degrees C at the time of application of joint sealing material. Excess material on exposed surfaces of the concrete shall be removed immediately and concrete surfaces cleaned.

### 3.5.3 Reinforcement Steel Placement

Reinforcement steel shall be accurately and securely fastened in place with suitable supports and ties before the concrete is placed.

## 3.6 CURB AND GUTTER JOINTS

Curb and gutter joints shall be constructed at right angles to the line of curb and gutter.

### 3.6.1 Contraction Joints

Contraction joints shall be constructed directly opposite contraction joints in abutting portland cement concrete pavements and spaced so that monolithic sections between curb returns will not be less than 1.5 m nor greater than 4.5 m in length. Contraction joints shall be constructed by means of 3 mm thick separators and of a section conforming to the cross section of the curb and gutter. Separators shall be removed as soon as practicable after concrete has set sufficiently to preserve the width and shape of the joint and prior to finishing.

### 3.6.2 Expansion Joints

Expansion joints shall be formed by means of preformed expansion joint filler material cut and shaped to the cross section of curb and gutter. Expansion joints shall be provided in curb and gutter directly opposite expansion joints of abutting portland cement concrete pavement, and shall be of the same type and thickness as joints in the pavement. Where curb and gutter do not abut portland cement concrete pavement, expansion joints at least 9.5 mm in width shall be provided at intervals not exceeding 45 meters. Expansion joints shall be provided in nonreinforced concrete gutter at locations indicated. Expansion joints shall be sealed immediately



following curing of the concrete or as soon thereafter as weather conditions permit.

Expansion joints and the top 25 mm depth of curb and gutter contraction-joints shall be sealed with joint sealer. The joint opening shall be thoroughly cleaned before the sealing material is placed. Sealing shall be done so that the material will not be spilled on exposed surfaces of the concrete. Concrete at the joint shall be surface dry and atmospheric and concrete temperatures shall be above 10 degrees C at the time of application of joint sealing material. Excess material on exposed surfaces of the concrete shall be removed immediately and concrete surfaces cleaned.

### 3.7 CURING AND PROTECTION

#### 3.7.1 General Requirements

Concrete shall be protected against loss of moisture and rapid temperature changes for at least 7 days from the beginning of the curing operation. Unhardened concrete shall be protected from rain and flowing water. All equipment needed for adequate curing and protection of the concrete shall be on hand and ready for use before actual concrete placement begins. Protection shall be provided as necessary to prevent cracking of the pavement due to temperature changes during the curing period.

##### 3.7.1.1 Mat Method

The entire exposed surface shall be covered with two or more layers of burlap. Mats shall overlap each other at least 150 mm. The mat shall be thoroughly wetted with water prior to placing on concrete surface and shall be kept continuously in a saturated condition and in intimate contact with concrete for not less than 7 days.

##### 3.7.1.2 Impervious Sheeting Method

The entire exposed surface shall be wetted with a fine spray of water and then covered with impervious sheeting material. Sheets shall be laid directly on the concrete surface with the light-colored side up and overlapped 300 mm when a continuous sheet is not used. The curing medium shall not be less than 450 mm wider than the concrete surface to be cured, and shall be securely weighted down by heavy wood planks, or a bank of moist earth placed along edges and laps in the sheets. Sheets shall be satisfactorily repaired or replaced if torn or otherwise damaged during curing. The curing medium shall remain on the concrete surface to be cured for not less than 7 days.

##### 3.7.1.3 Membrane Curing Method

A uniform coating of white-pigmented membrane-curing compound shall be applied to the entire exposed surface of the concrete as soon after finishing as the free water has disappeared from the finished surface. Formed surfaces shall be coated immediately after the forms are removed and in no case longer than 1 hour after the removal of forms. Concrete shall not be allowed to dry before the application of the membrane. If any drying has occurred, the surface of the concrete shall be moistened with a fine spray of water and the curing compound applied as soon as the free water disappears. Curing compound shall be applied in two coats by hand-operated pressure sprayers at a coverage of approximately 5 square meters per liter

(200 square feet per gallon) for both coats. The second coat shall be applied in a direction approximately at right angles to the direction of application of the first coat. The compound shall form a uniform, continuous, coherent film that will not check, crack, or peel and shall be free from pinholes or other imperfections. If pinholes, abrasion, or other discontinuities exist, an additional coat shall be applied to the affected areas within 30 minutes. Concrete surfaces that are subjected to heavy rainfall within 3 hours after the curing compound has been applied shall be resprayed by the method and at the coverage specified above. Areas where the curing compound is damaged by subsequent construction operations within the curing period shall be resprayed. Necessary precautions shall be taken to insure that the concrete is properly cured at sawed joints, and that no curing compound enters the joints. The top of the joint opening and the joint groove at exposed edges shall be tightly sealed before the concrete in the region of the joint is resprayed with curing compound. The method used for sealing the joint groove shall prevent loss of moisture from the joint during the entire specified curing period. Approved standby facilities for curing concrete pavement shall be provided at a location accessible to the jobsite for use in the event of mechanical failure of the spraying equipment or other conditions that might prevent correct application of the membrane-curing compound at the proper time. Concrete surfaces to which membrane-curing compounds have been applied shall be adequately protected during the entire curing period from pedestrian and vehicular traffic, except as required for joint-sawing operations and surface tests, and from any other possible damage to the continuity of the membrane.

### 3.7.2 Backfilling

After curing, debris shall be removed and the area adjoining the concrete shall be backfilled, graded, and compacted to conform to the surrounding area in accordance with lines and grades indicated.

### 3.7.3 Protection

Completed concrete shall be protected from damage until accepted. The Contractor shall repair damaged concrete and clean concrete discolored during construction. Concrete that is damaged shall be removed and reconstructed for the entire length between regularly scheduled joints. Refinishing the damaged portion will not be acceptable. Removed damaged portions shall be disposed of as directed.

### 3.7.4 Protective Coating

Protective coating of linseed oil mixture shall be applied to the exposed-to-view concrete surface.

#### 3.7.4.1 Application

Curing and backfilling operation shall be completed prior to applying protective coating. Concrete shall be surface dry and thoroughly clean before each application. Coverage shall be not more than 11 square meters per liter for first application and not more than 15.5 square meters per liter for second application, except that the number of applications and coverage for each application for commercially prepared mixture shall be in accordance with the manufacturer's instructions. Coated surfaces shall be protected from vehicular and pedestrian traffic until dry.

#### 3.7.4.2 Precautions

Protective coating shall not be heated by direct application of flame or electrical heaters and shall be protected from exposure to open flame, sparks, and fire adjacent to open containers or applicators. Material shall not be applied at temperatures lower than 10 degrees C.

### 3.8 FIELD QUALITY CONTROL

#### 3.8.1 General Requirements

The Contractor shall perform the inspection and tests described and meet the specified requirements for inspection details and frequency of testing. Based upon the results of these inspections and tests, the Contractor shall take the action and submit reports as required below, and any additional tests to insure that the requirements of these specifications are met.

#### 3.8.2 Concrete Testing

##### 3.8.2.1 Strength Testing

The Contractor shall provide molded concrete specimens for strength tests. Samples of concrete placed each day shall be taken not less than once a day nor less than once for every 190 cubic meters of concrete. The samples for strength tests shall be taken in accordance with ASTM C 172. Cylinders for acceptance shall be molded in conformance with ASTM C 31 by an approved testing laboratory. Each strength test result shall be the average of two test cylinders from the same concrete sample tested at 28 days, unless otherwise specified or approved. Concrete specified on the basis of compressive strength will be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed the specified strength, and no individual strength test result falls below the specified strength by more than 4 MPa.

##### 3.8.2.2 Air Content

Air content shall be determined in accordance with ASTM C 173 or ASTM C 231. ASTM C 231 shall be used with concretes and mortars made with relatively dense natural aggregates. Two tests for air content shall be made on randomly selected batches of each class of concrete placed during each shift. Additional tests shall be made when excessive variation in concrete workability is reported by the placing foreman or the Government inspector. If results are out of tolerance, the placing foreman shall be notified and he shall take appropriate action to have the air content corrected at the plant. Additional tests for air content will be performed on each truckload of material until such time as the air content is within the tolerance specified.

##### 3.8.2.3 Slump Test

Two slump tests shall be made on randomly selected batches of each class of concrete for every 190 cubic meters, or fraction thereof, of concrete placed during each shift. Additional tests will be performed when excessive variation in the workability of the concrete is noted or when excessive crumbling or slumping is noticed along the edges of slip-formed concrete.

### 3.8.3 Thickness Evaluation

The anticipated thickness of the concrete shall be determined prior to placement by passing a template through the formed section or by measuring the depth of opening of the extrusion template of the curb forming machine. If a slip form paver is used for sidewalk placement, the subgrade shall be true to grade prior to concrete placement and the thickness will be determined by measuring each edge of the completed slab.

### 3.8.4 Surface Evaluation

The finished surface of each category of the completed work shall be uniform in color and free of blemishes and form or tool marks.

## 3.9 SURFACE DEFICIENCIES AND CORRECTIONS

### 3.9.1 Thickness Deficiency

When measurements indicate that the completed concrete section is deficient in thickness by more than 6 mm the deficient section will be removed, between regularly scheduled joints, and replaced.

### 3.9.2 High Areas

In areas not meeting surface smoothness and plan grade requirements, high areas shall be reduced either by rubbing the freshly finished concrete with carborundum brick and water when the concrete is less than 36 hours old or by grinding the hardened concrete with an approved surface grinding machine after the concrete is 36 hours old or more. The area corrected by grinding the surface of the hardened concrete shall not exceed 5 percent of the area of any integral slab, and the depth of grinding shall not exceed 6 mm. All pavement areas requiring grade or surface smoothness corrections in excess of the limits specified above shall be removed and replaced.

### 3.9.3 Appearance

Exposed surfaces of the finished work will be inspected by the Government and any deficiencies in appearance will be identified. Areas which exhibit excessive cracking, discoloration, form marks, or tool marks or which are otherwise inconsistent with the overall appearances of the work shall be removed and replaced.

SECTION 02526

WHEEL STOPS

1 GENERAL (NOT APPLICABLE)

2 PRODUCTS

Wheel stops shall be precast reinforced concrete construction.

2.1 CONCRETE WHEEL STOPS

Concrete wheel stops shall be constructed of reinforced concrete conforming to the SECTION 03300 with a minimum compressive strength strength of 30 MPa at 28 days. The stops shall be constructed as detailed on the drawings, or may be approved manufactured items.

3 EXECUTION

Installation shall be as recommended by the manufacturer at the locations shown.

## SECTION 02552

## BITUMINOUS SURFACE COURSE

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

## MILITARY STANDARD (MIL-STD)

MIL-STD-620A	(Rev A, & Notice 1) Test Methods for Bituminous Paving Materials RefTitle
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## OKLAHOMA DEPARTMENT OF TRANSPORTATION (ODOT)

ODOT State Standards	Standard Specifications for Highway Construction (1996 - Metric)
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## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 117	(1995) Standard Test Method for Materials Finer than 75- $\mu$ m (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 128	(1993) Standard Test Method for Specific Gravity and Absorption of Fine Aggregate
ASTM C 136	(1996a) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C 183	(1995a) Standard Practice for Sampling and the Amount of Testing of Hydraulic Cement
ASTM D 75	(1987, (1992 e1)) Standard Practice for Sampling Aggregates
ASTM D 140	(1993) Standard Practice for Sampling Bituminous Materials

## 1.2 PLANT, EQUIPMENT, MACHINES, AND TOOLS

## 1.2.1 General

The bituminous plant shall be of such capacity to produce the quantities of bituminous mixtures required. Hauling equipment, paving machines, rollers, miscellaneous equipment, and tools shall be provided in sufficient numbers and capacity and in proper working condition to place the bituminous paving mixtures at a rate equal to the plant output.

## 1.2.2 Straightedge

The Contractor shall furnish and maintain at the site, in good condition, one 12-foot straightedge for each bituminous paver. Straightedge shall be

made available for Government use. Straightedges shall be constructed of aluminum or other lightweight metal and shall have blades of box or box-girder cross section with flat bottom reinforced to insure rigidity and accuracy. Straightedges shall have handles to facilitate movement on pavement.

### 1.3 WEATHER LIMITATIONS

Unless otherwise directed, bituminous courses shall not be constructed when temperature of the surface of the existing pavement or base course is below 5 degrees C.

### 1.4 PROTECTION OF PAVEMENT

After final rolling, no vehicular traffic of any kind shall be permitted on the pavement until the pavement has cooled to 60 degrees C.

### 1.5 GRADE AND SURFACE-SMOOTHNESS REQUIREMENTS

Finished surface of bituminous courses, when tested as specified below shall conform to gradeline and elevations shown and to surface-smoothness requirements specified.

#### 1.5.1 Plan Grade

The grade of the completed surface shall not deviate more than 15 mm from the plan grade.

#### 1.5.2 Surface Smoothness

When a 4 m straightedge is laid on the surface, the surface shall not vary more than 6 mm from the straightedge.

### 1.6 GRADE CONTROL

Lines and grades shall be established and maintained by means of line and grade stakes placed at site of work. Elevations of bench marks used by the Contractor for controlling pavement operations at the site of work will be determined, established, and maintained by the Government. Finished pavement elevations shall be established and controlled at the site of work by the Contractor in accordance with bench mark elevations furnished by the Contracting Officer.

### 1.7 SAMPLING AND TESTING

Sampling and testing shall be the responsibility of the Contractor. Sampling and testing shall be performed by an approved commercial testing laboratory or by the Contractor subject to approval. Unless otherwise specified, sampling shall be in accordance with ASTM D 75 for aggregates, ASTM C 183 for mineral filler, and ASTM D 140 for bituminous material. Copies of test results shall be furnished to the Contracting Officer. Approval of a source does not relieve the Contractor of responsibility for delivery at the job site of materials meeting the requirements herein. Required tests, test frequencies of test standards shall be as follows:

#### 1.7.1 Hot bin gradations (cold-feed gradation when drum mix plant is used):

One test per 367 MT of mix or fraction thereof. ASTM C 136 and ASTM C 117.

#### 1.7.2 Marshall Specimens

Two sets (three specimens per set) per day and/or at least one set per each 367 MT of mix placed. See Paragraph: "Test Properties of Bituminous Mixtures" for test standards.

#### 1.7.3 Asphalt Extraction

One test per 367 MT of mix (at least one per day). See Paragraph: "Test Properties of Bituminous Mixture" for test standards.

#### 1.7.4 Field and Lab Density Tests

One lab density and one field density set per 367 MT of mix or fraction thereof (three specimens per set). MIL-STD-630. Method 101 (field test), MIL-STD-620A, Method 100 (lab test).

#### 1.7.5 Thickness Measurements

One measurement for each 849 square meters.

### 1.8 ACCESS TO PLANT AND EQUIPMENT

The Contracting Officer shall have access at all times to all parts of the paving plant for checking adequacy of the equipment in use, inspecting operation of the plant, verifying weights, proportions, and character of materials, and checking temperatures maintained in preparation of the mixtures.

## 2 PRODUCTS

### 2.1 HOT-MIX SURFACE COURSE

Bituminous hot-mix surface course shall conform to the requirements of the ODOT State Standards for Plant Mix Asphalt Concrete Pavement Section 411 except as specified hereinafter.

#### 2.1.1 Asphalt Material

Asphalt material for the surface course shall be asphalt cement, Type AC-20, conforming to ODOT Standard Specification for "Asphalt Materials", Section 708.03. Asphalt material shall come from a source approved for use by the Oklahoma Department of Transportation. The seal number from the tank and the number of the Oklahoma Department of Transportation's Laboratory test report shall be furnished to the Contracting Officer.

#### 2.1.2 Paving Mixture Type

Paving mixture shall be Type "B".



### 2.1.3 Modifications to ODOT Standard Specifications

ODOT Specifications shall be modified as follows:

- (a) The measurement and payment paragraphs shall not apply

## 2.2 PROPORTIONING OF MIXTURE

### 2.2.1 Job Mix Formula(JMF)

No bituminous mixture shall be manufactured until the grading and asphalt content of the proposed mix has been furnished by the plant for the Contracting Officer's approval. The formula will indicate the percentage of each sieve fraction of aggregate, percentage of asphalt, and temperature of the completed mixture when discharged from the mixer. The job-mix formula will be allowed the tolerances specified in the ODOT Standard Specification, Section 411. The bitumen content and aggregate gradation may be adjusted within the limits of the gradation tables specified therein to improve the paving mixtures, as directed, without adjustments in the contract price. The percentages of each sieve fraction in the job-mix formula will be restricted to values such that the applicable of the specified tolerances will not cause the limits of the gradation tables to be exceeded.

## 3 EXECUTION

### 3.1 WEATHER LIMITATIONS

Bituminous courses shall not be constructed when the temperature of the surface of the existing pavement or base course is below 7 C nor when there is frost in the underlying course. The minimum air temperature for the bituminous mixtures shall be 7 C and rising. Bituminous mixtures shall not be constructed when the air temperature is 7 C and falling, or when a strong wind is blowing or conditions otherwise are such that the mixture becomes chilled to an extent which prevents proper leveling and thorough consolidation.

### 3.2 BASE COURSE CONDITIONING

The surface of the base course will be inspected for adequate compaction and surface tolerances specified in Section 02241. Unsatisfactory areas shall be corrected.

### 3.3 STORAGE OF BITUMINOUS PAVING MIXTURE

Storage shall conform to the applicable requirements of ASTM D 3515; however, in no case shall the mixture be stored for more than 4 hours.

### 3.4 TRANSPORTATION OF BITUMINOUS MIXTURE

Transportation from paving plant to site shall be in trucks having tight, clean, smooth beds lightly coated with an approved releasing agent to prevent adhesion of the mixture to the truck bodies. Excessive releasing agent shall be drained prior to loading. Each load shall be covered with canvas or other approved material of ample size to protect mixture from weather and prevent loss of heat. Loads that have crusts of cold, unworkable material or that have become wet will be rejected. Hauling over freshly placed material will not be permitted.

### 3.5 SURFACE PREPARATION OF UNDERLYING COURSE

Prior to placing of the intermediate or wearing course, the underlying course shall be cleaned of all foreign or objectionable matter with power brooms and hand brooms.

### 3.6 PRIME COATING

Surfaces of previously constructed base course shall be sprayed with a coat of bituminous material in accordance with Section 02559.

### 3.7 PLACING

Bituminous courses shall be constructed only when the base course or existing pavement has no free water on the surface. Bituminous mixtures shall not be placed without ample time to complete spreading and rolling during daylight hours, unless approved satisfactory artificial lighting is provided.

#### 3.7.1 Offsetting Joints

The surface course shall be placed so that longitudinal joints of the top course will be offset from joints in the underlying course by at least 1 foot. Transverse joints in the surface course shall be offset by at least 2 feet from transverse joints in the underlying course.

#### 3.7.2 General Requirements for Use of Mechanical Spreader

Range of temperatures of mixtures, when dumped into the mechanical spreader, shall be as determined by the Contracting Officer. Mixtures having temperatures less than 107 degrees C when dumped into the mechanical spreader shall not be used. The mechanical spreader shall be adjusted and the speed regulated so that the surface of the course being laid will be smooth and continuous without tears and pulls, and of such depth that, when compacted, the surface will conform to the cross section indicated. Placing with respect to centerline areas with crowned sections or high side of areas with one-way slope shall be as directed. Placing of the mixture shall be as nearly continuous as possible, and speed of placing shall be adjusted, as directed, to permit proper rolling. When segregation occurs in the mixture during placing, the spreading operation shall be suspended until the cause is determined and corrected.

#### 3.7.3 Placing Strips Succeeding Initial Strips

In placing each succeeding strip after initial strip has been spread and compacted as specified below, the screed of the mechanical spreader shall overlap the previously placed strip 50 to 75 mm and be sufficiently high so that compaction produces a smooth dense joint. Mixture placed on the edge of a previously placed strip by the mechanical spreader shall be pushed back to the edge of the strip by use of a lute. Excess mixture shall be removed and wasted.

#### 3.7.4 Handspreading in Lieu of Machine Spreading

In areas where the use of machine spreading is impractical, the mixture shall be spread by hand. Spreading shall be in a manner to prevent

segregation. The mixture shall be spread uniformly with hot rakes in a loose layer of thickness that, when compacted, will conform to required grade, density, and thickness.

### 3.8 COMPACTION OF MIXTURE

Rolling shall begin as soon after placing as the mixture will bear a roller without undue displacement. Delays in rolling freshly spread mixture will not be permitted. After initial rolling, preliminary tests of grade and smoothness shall be made by the Contractor. Deficiencies shall be corrected so that the finished course will conform to requirements for grade and smoothness specified herein. After the Contractor is assured of meeting crown, grade, and smoothness requirements, rolling shall be continued until a mat density of 97.0 to 100.0 percent and a joint density of 95.0 to 100.0 percent of density of laboratory-compacted specimens of the same mixture is obtained. Places inaccessible to rollers shall be thoroughly compacted with hot hand tampers.

### 3.9 CORRECTING DEFICIENT AREAS

Mixtures that become contaminated or are defective shall be removed to the full thickness of the course. Edges of the area to be removed shall be cut so that sides are perpendicular and parallel to the direction of traffic and so that the edges are vertical. Edges shall be sprayed with bituminous materials. Fresh paving mixture shall be placed in the excavated areas in sufficient quantity so that the finished surface will conform to grade and smoothness requirements. Paving mixture shall be compacted to the density specified herein. Skin patching of an area that has been rolled will not be permitted.

### 3.10 JOINTS

#### 3.10.1 General

Joints between old and new pavements, between successive days' work, or joints that have become cold (less than 79 degrees C) shall be made to insure continuous bond between the old and new sections of the course. All joints shall have the same texture and smoothness as other sections of the course. All cold joints shall have a minimum of two inches of material removed for the full lift thickness by sawing, shearing, or other procedure as may be approved to ensure that an even, vertical face of dense material is available against which to compact the adjacent paving lane. All material removed shall be gathered and weighed for deduction from the total tonnage of mixture placed.

Contact surfaces of previously constructed pavements coated by dust, sand, or other objectionable material shall be cleaned by brushing or shall be cut back as directed. When directed by the Contracting Officer, the surface against which new material is placed shall be sprayed with a thin, uniform coat of bituminous material. Material shall be applied far enough in advance of placement of a fresh mixture to insure adequate curing. Care shall be taken to prevent damage or contamination of the sprayed surface.

#### 3.10.2 Transverse Joints

The roller shall pass over the unprotected end of a strip of freshly placed material only when placing is discontinued or delivery of the mixture is

interrupted to the extent that the material in placed may become cold. In all cases, prior to continuing placement, the edge of previously placed pavement shall be cut back to expose an even vertical surface for full thickness of the course. In continuing placement of a strip, the mechanical spreader shall be positioned on the transverse joint so that sufficient hot mixture will be spread to obtain a joint after rolling that conforms to the required density and smoothness specified herein.

#### 3.10.3 Longitudinal Joints

Edges of a previously placed strip shall be prepared such that the pavement in and immediately adjacent to the joint between this strip and the succeeding strip meets the requirements for grade, smoothness, and density specified.

## SECTION 02558

## BITUMINOUS TACK COAT

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 2397 (1997) Standard Specification for Cationic Emulsified Asphalt

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300.

SD-07 Schedules

Construction Equipment List; FIO.

All plant, equipment, machines and tools used in the work shall be subject to approval and shall be maintained in a satisfactory working condition at all times.

## 1.3 PLANT, EQUIPMENT, MACHINES AND TOOLS

## 1.3.1 General Requirements

The equipment shall be adequate and shall have the capability of producing the results specified.

## 1.3.2 Bituminous Distributor

The distributor shall have pneumatic tires of such size and number to prevent rutting, shoving, or otherwise damaging the base surface or other layers in the pavement structure. It shall be designed and equipped to spray the bituminous material in a uniform double or triple lap at the specified temperature, at readily determined and controlled rates with an allowable variation from the specified rate of not more than plus or minus 5 percent, and at variable widths. Distributor equipment shall include a separate power unit for the bitumen pump, full-circulation spray bars, tachometer, pressure gauges, volume-measuring devices, adequate heaters for heating of materials to the proper application temperature, a thermometer for reading the temperature of tank contents, and a hand hose attachment suitable for applying bituminous material manually to areas inaccessible to the distributor. The distributor shall be equipped to circulate and agitate the bituminous material during the heating process.

### 1.3.3 Power Brooms and Power Blowers

Power brooms and power blowers shall be suitable for cleaning the surfaces to which the prime coat is to be applied.

### 1.3.4 Storage Tanks

Tanks shall be capable of heating the bituminous material, under effective and positive control at all times, to the required temperature. Heating shall be accomplished by steam coils, hot oil, or electricity. An armored thermometer shall be affixed to the tank so that the temperature of the bituminous material may be read at all times.

## 1.4 WEATHER LIMITATIONS

The prime coat shall be applied only when the subgrade, subbase, or base course is dry enough to promote uniform coverage and the desired penetration into the treated surface. The prime coat shall be applied only when the atmospheric temperature in the shade is 10 degrees C or above and when the temperature has not been below 2 degrees C for the 12 hours prior to the application.

## 2 PRODUCTS

### 2.1 BITUMINOUS MATERIALS

Emulsified asphalt shall conform to ASTM D 2397, Grade CSS-1.

## 3 EXECUTION

### 3.1 PREPARATION OF SURFACE

Immediately before applying the tack coat, all loose material, dirt, clay or other objectionable material shall be removed from the surface to be treated. The area to be tacked shall also be dry and clean.

### 3.2 APPLICATION RATE

Bituminous material for the tack coat shall be applied in quantities of not less than 0.22 liters nor more than 0.67 liters per square meter of pavement surface. The exact quantities within the range specified, which may be varied to suit field conditions, will be determined by the Contracting Officer.

### 3.3 APPLICATION TEMPERATURE

Asphalt application temperature shall provide an application viscosity between 10 and 60 seconds, Saybolt Furol, or between 20 and 120 sq mm/sec, kinematic. The temperature viscosity relation shall be furnished to the Contracting Officer.

These temperature ranges include or exceed the flash point of the material, and care should be taken in their heating.

### 3.4 APPLICATION

Following preparation and subsequent inspection of the surface, the tack coat shall be applied at the specified rate with uniform distribution over the surface to be treated. All areas and spots missed by the distributor shall be properly treated with the hand spray. Following application of the tack material, and prior to application of the succeeding layer of pavement, the tack coat shall be allowed to cure and to obtain evaporation of any volatiles or moisture. Until the succeeding layer of pavement is placed, the tacked surface shall be maintained by protecting the surface against damage and by repairing and retacking deficient areas at no additional cost to the Government. If required, clean dry sand shall be spread to effectively blot up any excess bituminous material. No smoking, fires, or flames other than the heaters that are a part of the equipment shall be permitted within 7.5 m of heating, distributing, and transferring operations of bituminous material other than bituminous emulsions.

Samples of the bituminous material used will be obtained by the Contractor as directed, under the supervision of the Contracting Officer. The sample will be retained and tested by the Government at no cost to the Contractor.

## SECTION 02559

## BITUMINOUS PRIME COAT

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## OKLAHOMA DEPARTMENT OF TRANSPORTATION (ODOT)

ODOT State Standards	Standard Specifications for Highway Construction (1996 - Metric)
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## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 2995	(1993) Determining Application Rate of Bituminous Distributors
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## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300.

## SD-09 Reports

Sampling and Testing; FIO.

Copies of test results shall be furnished to the Contracting Officer, as required in paragraph: Bituminous Material.

## 1.3 PLANT, EQUIPMENT, MACHINES AND TOOLS

## 1.3.1 General Requirements

All plant, equipment, machines and tools used in the work shall be subject to approval and shall be maintained in a satisfactory working condition at all times. The equipment shall be adequate and shall have the capability of producing the results specified.

## 1.3.2 Bituminous Distributor

The distributor shall have pneumatic tires of such size and number to prevent rutting, shoving, or otherwise damaging the base surface or other layers in the pavement structure. It shall be designed and equipped to spray the bituminous material in a uniform double or triple lap at the specified temperature, at readily determined and controlled rates with an allowable variation from the specified rate of not more than plus or minus 5 percent, and at variable widths. Distributor equipment shall include a separate power unit for the bitumen pump, full-circulation spray bars, tachometer, pressure gauges, volume-measuring devices, adequate heaters for heating of materials to the proper application temperature, a thermometer for reading the temperature of tank contents, and a hand hose attachment



suitable for applying bituminous material manually to areas inaccessible to the distributor. The distributor shall be equipped to circulate and agitate the bituminous material during the heating process.

#### 1.3.3 Power Brooms and Power Blowers

Power brooms and power blowers shall be suitable for cleaning the surfaces to which the prime coat is to be applied.

#### 1.3.4 Storage Tanks

Tanks shall be capable of heating the bituminous material, under effective and positive control at all times, to the required temperature. Heating shall be accomplished by steam coils, hot oil, or electricity. An armored thermometer shall be affixed to the tank so that the temperature of the bituminous material may be read at all times.

### 1.4 WEATHER LIMITATIONS

The prime coat shall be applied only when the subgrade, subbase, or base course is dry enough to promote uniform coverage and the desired penetration into the treated surface. The prime coat shall be applied only when the atmospheric temperature in the shade is 10 degrees C or above and when the temperature has not been below 2 degrees C for the 12 hours prior to the application.

## 2 PRODUCTS

### 2.1 BITUMINOUS MATERIALS

Cutback asphalt, grade MC-30 or MC-70, conforming to ODOT State Standards "Asphalt Materials," Section 708.03. Bituminous material delivered to the job shall come from a source approved for use by the Oklahoma Department of Transportation. The seal number from the tank and a copy of the ODOT Laboratory test report shall accompany each shipment, or the Contractor shall furnish a test report certifying the material meets the specified requirements.

## 3 EXECUTION

### 3.1 PREPARATION OF SURFACE

Immediately before applying the prime coat, all loose material, dirt, clay, or other objectionable material shall be removed from the surface to be treated. To assure a uniform spread of the bituminous material, the portion of the subgrade, subbase, or base course prepared for treatment, if excessively dry, shall be lightly sprinkled with water immediately before the application, as directed.

### 3.2 PRIME COATING

#### 3.2.1 Application Rate

Bituminous material for the prime coat shall be applied in quantities of not less than 0.67 liters nor more than 1.80 liters per square meter of pavement surface. The exact quantities within the range specified, which may be

varied to suit field conditions, will be determined by the Contracting Officer.

### 3.2.2 Application Temperature

#### NORMAL SPRAY APPLICATION TEMPERATURES FOR CUTBACK ASPHALTS

MC-30	29-87 degrees C
MC-70	50-107 degrees C

Cutback asphalt application temperature shall provide an application viscosity between 10 and 60 seconds, Saybolt Furol, or between 20 and 120 sq mm/sec, kinematic. The temperature viscosity relation shall be furnished to the Contracting Officer.

These temperature ranges include or exceed the flash point of the material, and care should be taken in their heating.

### 3.2.3 Application

Following preparation and subsequent inspection of the surface, the prime coat shall be applied at the specified rate with uniform distribution over the surface to be treated. To obtain uniform application of the prime coat on the surface treated at the junction of previous and subsequent applications, building paper shall be spread on the surface for a sufficient distance back from the ends of each application so that the prime coat may be started and stopped on the paper. Immediately after application, the building paper shall be removed and destroyed. All areas and spots missed by the distributor shall be properly treated with the hand spray. Following application of the prime material, the surface shall be allowed to cure without being disturbed for a period of at least 48 hours or longer, as may be necessary to attain penetration into the treated course and evaporation of the volatiles from prime material. As directed, sand shall be spread to effectively blot up and cure any excess bituminous material. Until the succeeding layer of pavement is placed, the primed surface shall be maintained by protecting the surface against damage and by repairing and repriming deficient areas at no additional cost to the Government. No smoking, fire, or flames other than the heaters that are a part of the equipment shall be permitted within 7.5 m feet of heating, distributing, or transferring operation for bituminous materials other than emulsions.

### 3.3 FIELD QUALITY CONTROL

Samples of the bituminous material used will be obtained by the Contractor as directed, under the supervision of the Contracting Officer. The sample will be retained and tested by the Government at no cost to the Contractor.

### 3.4 SAMPLING AND TESTING

#### 3.4.1 Initial Sampling and Testing

##### 3.4.1.1 Calibration Test

The Contractor shall furnish all equipment, materials, and labor necessary to calibrate the bituminous distributor. Calibration shall be made with the approved job material and prior to applying the prime coat material to the

prepared surface. Calibration of the bituminous distributor shall be in accordance with ASTM D 2995.

#### 3.4.1.2 Trial Applications

As a preliminary to providing the complete prime coat, three lengths of at least 30 meters for the full width of the distributor bar shall be primed to evaluate the amount of prime that can be satisfactorily applied. Unless otherwise authorized, the trial application rate of bituminous materials shall be applied in the amount of 1.14 liters per square meter . Other trial applications shall be made using various amounts of material as may be deemed necessary.

#### 3.4.2 Sampling and Testing During Construction

Quality control sampling and testing shall be performed as required in paragraph "FIELD QUALITY CONTROL."

## SECTION 02580

## PAVEMENT MARKINGS

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS  
(AASHTO)

AASHTO M 248 (1991I) Ready-Mixed White and Yellow Traffic  
Paints

## 1.2 DELIVERY AND STORAGE

All materials shall be delivered and stored in sealed containers that plainly show the designated name, formula or specification number, batch number, color, date of manufacture, manufacturer's name, and directions, all of which shall be plainly legible at time of use.

## 1.3 EQUIPMENT

All machines, tools and equipment used in the performance of the work shall be approved and maintained in satisfactory operating condition.

## 1.3.1 Surface Preparation Equipment

## 1.3.1.1 Sandblasting Equipment

Sandblasting equipment shall include an air compressor, hoses, and nozzles of proper size and capacity as required for cleaning surfaces to be painted. The compressor shall be capable of furnishing not less than 70.8 liters per sec of air at a pressure of not less than 620 kPa at each nozzle used, and shall be equipped with traps that will maintain the compressed air free of oil and water.

## 1.3.1.2 Waterblast Equipment

The water pressure shall be specified at 17.9 MPa at 60 degrees C in order to adequately clean the surfaces to be marked.

## 1.3.2 Traffic Controls

Suitable warning signs shall be placed near the beginning of the worksite and well ahead of the worksite for alerting approaching traffic from both directions.

## 1.4 HAND-OPERATED, PUSH-TYPE MACHINES

All machines, tools, and equipment used in performance of the work shall be approved and maintained in satisfactory operating condition. Hand-operated

push-type machines of a type commonly used for application of paint to pavement surfaces shall be acceptable for marking small streets and parking areas. Applicator machine shall be equipped with the necessary paint tanks and spraying nozzles, and shall be capable of applying paint uniformly at coverage specified. Sandblasting equipment shall be provided as required for cleaning surfaces to be painted. Hand-operated spray guns shall be provided for use in areas where push-type machines cannot be used.

## 2 PRODUCTS

### 2.1 PAINT

The paint shall be homogeneous, easily stirred to smooth consistency, and shall show no hard settlement or other objectionable characteristics during a storage period of 6 months. Paint for roads and streets shall conform to AASHTO M 248, color as selected. Pavement marking paints shall comply with applicable state and local laws enacted to ensure compliance with Federal Clean Air Standards. Paint materials shall conform to the restrictions of the local Air Pollution Control District.

## 3 EXECUTION

### 3.1 SURFACE PREPARATION

Surfaces to be marked shall be thoroughly cleaned before application of the pavement marking material. Dust, dirt, and other granular surface deposits shall be removed by sweeping, blowing with compressed air, rinsing with water or a combination of these methods as required. Rubber deposits, surface laitance, existing paint markings, and other coatings adhering to the pavement shall be completely removed with scrapers, wire brushes, sandblasting, approved chemicals, or mechanical abrasion as directed. Areas of old pavement affected with oil or grease shall be scrubbed with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinsed thoroughly after each application. After cleaning, oil-soaked areas shall be sealed with cut shellac to prevent bleeding through the new paint. Pavement surfaces shall be allowed to dry, when water is used for cleaning, prior to striping or marking. Surfaces shall be recleaned, when work has been stopped due to rain.

### 3.2 APPLICATION

#### 3.2.1 Paint

Paint shall be applied to clean, dry surfaces, and only when air and pavement temperatures are above 5 degrees C and less than 35 degrees C. Paint temperature shall be maintained within these same limits. New asphalt pavement surfaces and new portland concrete cement shall be allowed to cure for a period of not less than 30 days before applications of paint. Paint shall be applied pneumatically with approved equipment at rate of coverage specified herein. The Contractor shall provide guide lines and templates as necessary to control paint application. Special precautions shall be taken in marking numbers, letters, and symbols. Edges of markings shall be sharply outlined.

#### 3.2.1.1 Rate of Application

Reflective Markings: Pigmented binder shall be applied evenly to the pavement area to be coated at a rate of 10 plus or minus 0.5 square meter per liter.

Nonreflective Markings: Paint shall be applied evenly to the pavement surface to be coated at a rate of 10 plus or minus 0.5 square meter per liter.

#### 3.2.1.2 Drying

The maximum drying time requirements of the paint specifications will be strictly enforced to prevent undue softening of bitumen, and pickup, displacement, or discoloration by tires of traffic. If there is a delay in drying of the markings, painting operations shall be discontinued until cause of the slow drying is determined and corrected.

## SECTION 02660

## WATER DISTRIBUTION SYSTEM

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36	(1994a) Carbon Structural Steel
ASTM B 88	(1993a) Seamless Copper Water Tube
ASTM D 1599	(1988) Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing, and Fittings
ASTM D 1784	(1992) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 1785	(1993) Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2241	(1993) Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2464	(1993) Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2466	(1993) Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D 2467	(1993) Socket-Type Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2564	(1993) Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 2657	(1990) Heat-Joining Polyolefin Pipe and Fittings
ASTM D 2774	(1972; R 1983) Underground Installation of Thermoplastic Pressure Piping
ASTM D 2855	(1993) Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D 2996	(1995) Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe

ASTM D 2997	(1995) Centrifugally Cast "Fiberglass" (Glass-Fiber-Reinforced-Thermosetting-Resin) Pipe
ASTM D 3839	(1994a) Underground Installation of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Pipe
ASTM F 477	(1993) Elastomeric Seals (Gaskets) for Joining Plastic Pipe

## AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(1983; R 1992) Pipe Threads, General Purpose (Inch)
ASME B16.26	(1988) Cast Copper Alloy Fittings for Flared Copper Tubes

## AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA B300	(1992) Hypochlorites
AWWA B301	(1992) Liquid Chlorine
AWWA C104	(1990) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C105	(1988) Polyethylene Encasement for Ductile- Iron Piping for Water and Other Liquids
AWWA C110	(1993) Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (75 mm through 1200 mm), for Water and Other Liquids
AWWA C111	(1990) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115	(1988) Flanged Ductile-Iron Pipe with Threaded Flanges
AWWA C151	(1991) Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids
AWWA C153	(1994) Ductile-Iron Compact Fittings, 3 In. Through 16 In., for Water and Other Liquids
AWWA C200	(1991) Steel Water Pipe - 6 In. (150 mm) and Larger
AWWA C300	(1989) Reinforced Concrete Pressure Pipe, Steel-Cylinder Type, for Water and Other Liquids
AWWA C301	(1992) Prestressed Concrete Pressure Pipe, Steel-Cylinder Type, for Water and Other Liquids



AWWA C303	(1987; Errata Jan 1988) Reinforced Concrete Pressure Pipe, Steel Cylinder Type, Pretensioned, for Water and Other Liquids
AWWA C500	(1993) Gate Valves for Water and Sewerage Systems
AWWA C502	(1985) Dry-Barrel Fire Hydrants
AWWA C509	(1994) Resilient-Seated Gate Valves for Water and Sewerage Systems
AWWA C600	(1993) Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA C606	(1987) Grooved and Shouldered Joints
AWWA C651	(1992) Disinfecting Water Mains
AWWA C701	(1988) Cold-Water Meters - Turbine Type, for Customer Service
AWWA C706	(1991; C706a) Direct-Reading Remote-Registration Systems for Cold-Water Meters
AWWA C707	(1982; R 1992) Encoder-Type Remote-Registration Systems for Cold-Water Meters
AWWA C800	(1989) Underground Service Line Valves and Fittings
AWWA C900	(1989; C900a) Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. Through 12 In., for Water Distribution
AWWA C901	(1988; Errata Apr 1988) Polyethylene (PE) Pressure Pipe and Tubing, 1/2 In. Through 3 In., for Water Service
AWWA C905	(1988) Polyvinyl Chloride (PVC) Water Transmission Pipe, Nominal Diameters 14 In. Through 36 In.
AWWA C950	(1988) Fiberglass Pressure Pipe
AWWA M23	(1980) Manual: PVC Pipe - Design and Installation

## ASBESTOS CEMENT PIPE PRODUCERS ASSOCIATION (ACPPA)

ACPPA-01	(1988) Recommended Work Practices for A/C Pipe
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## DUCTILE IRON PIPE RESEARCH ASSOCIATION (DIPRA)

DIPRA-01 (1992; Errata May 1993) Thrust Restraint  
Design for Ductile Iron Pipe

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS  
INDUSTRY (MSS)

MSS SP-80 (1987) Bronze Gate, Globe, Angle and Check  
Valves

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 24 (1992) Installation of Private Fire Service  
Mains and Their Appurtenances

NFPA 49 (1991) Hazardous Chemicals Data

NFPA 325M (1991) Fire Hazard Properties of Flammable  
Liquids, Gases, and Volatile Solids

NFPA 704 (1990) Identification of the Fire Hazards of  
Materials

## NSF INTERNATIONAL (NSF)

NSF Std 14 (1965; Rev Nov 1990) Plastics Piping System  
Components and Related Materials

## STEEL STRUCTURES PAINTING COUNCIL (SSPC)

SSPC Paint 21 (1991) White or Colored Silicone Alkyd Paint

SSPC Paint 25 (1991) Red Iron Oxide, Zinc Oxide, Raw  
Linseed Oil and Alkyd Primer (without Lead  
and Chromate Pigments)

## 1.2 PIPING

This section covers water supply, distribution, and service lines, and connections to building service at a point approximately 1.5 m outside buildings and structures to which service is required. The Contractor shall have a copy of the manufacturer's recommendations for each material or procedure to be utilized available at the construction site at all times.

## 1.2.1 Service Lines

Piping for water service lines less than 80 mm in diameter shall be polyvinyl chloride (PVC) plastic or copper tubing, unless otherwise shown or specified. Piping for water service lines for sizes 80 mm and larger shall be ductile iron or polyvinyl chloride (PVC) plastic unless otherwise shown or specified.

### 1.2.2 Distribution Lines 80 mm or Larger

Piping for water distribution lines 80 mm or larger shall be ductile iron or polyvinyl chloride (PVC) plastic (through 300 mm nominal diameter) unless otherwise shown or specified.

### 1.2.3 Supply Lines 80 mm or Larger

Piping for water supply lines 80 mm or larger shall be ductile iron or polyvinyl chloride (PVC) plastic (through 900 mm nominal diameter) unless otherwise shown or specified.

### 1.2.4 Sprinkler Supply Lines

Piping for water lines supplying sprinkler systems for building fire protection shall conform to NFPA 24 from the point of connection with the water distribution system to the building 1.5 m line.

### 1.2.5 Plastic Pipe

All plastic piping system components intended for transportation of potable water shall comply with NSF Std 14 and shall be legibly marked with their symbol.

### 1.2.6 Excavation, Trenching, and Backfilling

Excavation, trenching, and backfilling shall be in accordance with the applicable provisions of Section 02222, except as modified herein.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

#### SD-06 Instructions

Installation; GA.

The manufacturer's recommendations for each material or procedure to be utilized.

#### SD-08 Statements

Waste Water Disposal Method; GA.

The method proposed for disposal of waste water from hydrostatic tests and disinfection, prior to performing hydrostatic tests.

Satisfactory Installation; FIO.

A statement signed by the principal officer of the contracting firm stating that the installation is satisfactory and in accordance with the contract drawings and specifications and the manufacturer's prescribed procedures and techniques, upon completion of the project and before final acceptance.

## SD-09 Reports

Bacteriological Disinfection; FIO.

Test results from commercial laboratory verifying disinfection.

## SD-13 Certificates

Installation; FIO.

A statement signed by the manufacturer's field representative certifying that the Contractor's personnel are capable of properly installing the pipe on the project.

Meters; FIO.

Manufacturer's certificate stating that each meter furnished has been tested for accuracy of registration and compliance with the accuracy and capacity requirements of the appropriate AWWA standard.

## 1.4 HANDLING

Pipe and accessories shall be handled so as to ensure delivery to the trench in sound, undamaged condition. Particular care shall be taken not to injure the pipe coating or lining. If the coating or lining of any pipe or fitting is damaged, the repair shall be made by the Contractor at his expense in a satisfactory manner. No other pipe or material of any kind shall be placed inside a pipe or fitting after the coating has been applied. Pipe shall be carried into position and not dragged. Use of pinch bars and tongs for aligning or turning pipe will be permitted only on the bare ends of the pipe. The interior of pipe and accessories shall be thoroughly cleaned of foreign matter before being lowered into the trench and shall be kept clean during laying operations by plugging or other approved method. Before installation, the pipe shall be inspected for defects. Material found to be defective before or after laying shall be replaced with sound material without additional expense to the Government. Rubber gaskets that are not to be installed immediately shall be stored in a cool and dark place.

## 1.4.1 Miscellaneous Plastic Pipe and Fittings

Polyvinyl Chloride (PVC) pipe and fittings shall be handled and stored in accordance with the manufacturer's recommendations. Piping shall be covered with shade material while in storage. Storage facilities shall be classified and marked in accordance with NFPA 704, with classification as indicated in NFPA 49 and NFPA 325M.

## 2 PRODUCTS

## 2.1 PIPE

Pipe shall conform to the respective specifications and other requirements specified below.

## 2.1.1.1 Plastic Pipe

## 2.1.1.1.1 Polyvinyl Chloride (PVC) Plastic Pipe

Pipe, couplings and fittings shall be manufactured of material conforming to ASTM D 1784, Class 12454B. Material shall include ultraviolet inhibitors.

## a. Pipe Less Than 100 mm Diameter:

(1) Screw-Joint: Pipe shall conform to dimensional requirements of ASTM D 1785 Schedule 80, with joints meeting requirements of 1.03 MPa working pressure, 1.38 MPa hydrostatic test pressure, unless otherwise shown or specified. Pipe couplings when used, shall be tested as required by ASTM D 2464.

(2) Elastomeric-Gasket Joint: Pipe shall conform to dimensional requirements of ASTM D 1785. Schedule 40 with joints meeting the requirements of 1.03 MPa working pressure, 1.38 MPa hydrostatic test pressure, unless otherwise shown or specified, or it may be pipe conforming to requirements of ASTM D 2241, elastomeric joint, with the following applications:

SDR	Maximum Working Pressure MPa	Minimum Hydrostatic Pressure MPa
26	0.689	0.917
21	0.827	1.103
17	1.034	1.379
13.5	1.379	1.834

(3) Solvent Cement Joint: Pipe shall conform to dimensional requirements of ASTM D 1785 or ASTM D 2241 with joints meeting the requirements of 1.03 MPa working pressure and 1.38 MPa hydrostatic test pressure.

b. Pipe 100 mm through 300 mm Diameter: Pipe, couplings and fittings shall conform to AWWA C900, Class 150, CIOD pipe dimensions, elastomeric-gasket joint, unless otherwise shown or specified.

c. Pipe 350 mm through 900 mm Diameter: Pipe shall conform to AWWA C905 unless otherwise shown or specified.

## 2.1.1.2 Ductile-Iron Pipe

Ductile-iron pipe shall conform to AWWA C151, working pressure not less than 1.03 MPa, unless otherwise shown or specified. Pipe shall be cement-mortar lined in accordance with AWWA C104. Linings shall be standard. When installed underground, pipe shall be encased with 8 mil thick polyethylene in accordance with AWWA C105. Flanged ductile iron pipe with threaded flanges shall be in accordance with AWWA C115.

## 2.1.1.3 Copper Tubing

Copper tubing shall conform to ASTM B 88, Type K, annealed.

## 2.2 FITTINGS AND SPECIALS

### 2.2.1 Polyvinyl Chloride (PVC) Pipe

- a. For pipe less than 100 mm diameter, fittings for threaded pipe shall conform to requirements of ASTM D 2464, threaded to conform to the requirements of ASME B1.20.1 for use with Schedule 80 pipe and fittings, fittings for solvent cement jointing shall conform to ASTM D 2466 or ASTM D 2467, and fittings for elastomeric-gasket joint pipe shall be iron conforming to AWWA C110 or AWWA C111. Iron fittings and specials shall be cement-mortar lined (standard thickness) in accordance with AWWA C104.
- b. For pipe 100 mm diameter and larger, fittings and specials shall be iron, bell end in accordance with AWWA C110, 1.03 MPa pressure rating unless otherwise shown or specified, except that profile of bell may have special dimensions as required by the pipe manufacturer; or may be fittings and specials of the same material as the pipe with elastomeric gaskets, all in conformance with AWWA C900. Iron fittings and specials shall be cement-mortar lined (standard thickness) in accordance with AWWA C104. Fittings shall be bell and spigot or plain end pipe, or as applicable. Ductile iron compact fittings shall be in accordance with AWWA C153.

### 2.2.2 Ductile-Iron Pipe

Fittings and special shall be suitable for 1.03 MPa pressure rating, unless otherwise specified. Fittings and specials for mechanical joint pipe shall conform to AWWA C110. Fittings and specials for use with push-on joint pipe shall conform to AWWA C110 and AWWA C111. Fittings and specials for grooved and shouldered end pipe shall conform to AWWA C606. Fittings and specials shall be cement-mortar lined (standard thickness) in accordance with AWWA C104. Ductile iron compact fittings shall conform to AWWA C153.

#### 2.2.2.1 Dielectric Fittings

Dielectric fittings shall be installed between threaded ferrous and nonferrous metallic pipe, fittings and valves, except where corporation stops join mains. Dielectric fittings shall prevent metal-to-metal contact of dissimilar metallic piping elements and shall be suitable for the required working pressure.

### 2.2.3 Copper Tubing

Fittings and specials shall be flared and conform to ASME B16.26.

## 2.3 JOINTS

### 2.3.1 Plastic Pipe

#### 2.3.1.1 Polyvinyl Chloride Pipe

Joints, fittings, and couplings shall be as specified for PVC pipe. Joints connecting pipe of differing materials shall be made in accordance with the manufacturer's recommendations as approved by the Contracting Officer.

### 2.3.2 Ductile-Iron Pipe

- a. Mechanical joints shall be of the stuffing box type and shall conform to AWWA C111.
- b. Push-on joints shall conform to AWWA C111.
- c. Rubber gaskets and lubricant shall conform to the applicable requirements of AWWA C111.

### 2.3.3 Bonded Joints

For all ferrous pipe, a metallic bond shall be provided at each joint, including joints made with flexible couplings, caulking, or rubber gaskets, of ferrous-metallic piping to effect continuous conductivity. The bond wire shall be Size 1/0 copper conductor suitable for direct burial shaped to stand clear of the joint. The bond shall be of the thermal weld type.

### 2.3.4 Isolation Joints

Isolation joints shall be installed between nonthreaded ferrous and nonferrous metallic pipe, fittings and valves. Isolation joints shall consist of a sandwich-type flange isolation gasket of the dielectric type, isolation washers, and isolation sleeves for flange bolts. Isolation gaskets shall be full faced with outside diameter equal to the flange outside diameter. Bolt isolation sleeves shall be full length. Units shall be of a shape to prevent metal-to-metal contact of dissimilar metallic piping elements.

- a. Sleeve-type couplings shall be used for joining plain end pipe sections. The two couplings shall consist of one steel middle ring, two steel followers, two gaskets, and the necessary steel bolts and nuts to compress the gaskets.
- b. Split-sleeve type couplings may be used in aboveground installations when approved in special situations and shall consist of gaskets and a housing in two or more sections with the necessary bolts and nuts.

### 2.3.5 Copper Tubing

Joints shall be compression-pattern flared and shall be made with fittings hereinafter specified.

## 2.4 VALVES

### 2.4.1 Gate Valves

Gate valves shall be designed for a working pressure of not less than 1.03 MPa. Valve connections shall be as required for the piping in which they are installed. Valves shall have a clear waterway equal to the full nominal diameter of the valve, and shall be opened by turning counterclockwise. The operating nut or wheel shall have an arrow, cast in the metal, indicating the direction of opening.

- a. Valves smaller than 80 mm shall be all bronze and shall conform to MSS SP-80, Type 1, Class 150.

- b. Valves 80 mm and larger shall be iron body, bronze mounted, and shall conform to AWWA C500. Flanges shall not be buried. An approved pit shall be provided for all flanged connections.
- c. Resilient-Seated Gate Valves: For valves 80 to 300 mm in size, resilient-seated gate valves shall conform to AWWA C509.

#### 2.4.2 Indicator Post for Valves

Each valve shown on the drawings with the designation "P.I.V." shall be equipped with indicator post conforming to the requirements of NFPA 24. Operation shall be by a wrench which will be attached to each post.

#### 2.5 VALVE BOXES

Valve boxes shall be cast iron or concrete, except that concrete boxes may be installed only in locations not subjected to vehicular traffic. Cast-iron boxes shall be extension type with slide-type adjustment and with flared base. The minimum thickness of metal shall be 5 mm. Concrete boxes shall be the standard product of a manufacturer of precast concrete equipment. The word "WATER" shall be cast in the cover. The box length shall adapt, without full extension, to the depth of cover required over the pipe at the valve location.

#### 2.6 FIRE HYDRANTS

Hydrants shall be dry-barrel type conforming to AWWA C502 with valve opening at least 125 mm in diameter and designed so that the flange at the main valve seat can be removed with the main valve seat apparatus remaining intact, closed and reasonably tight against leakage and with a breakable valve rod coupling and breakable flange connections located no more than 200 mm above the ground grade. Hydrants shall have a 150 mm bell connection, two 65 mm hose connections and one 115 mm pumper connection. Outlets shall have American National Standard fire-hose coupling threads. Working parts shall be bronze. Design, material, and workmanship shall be similar and equal to the latest stock pattern ordinarily produced by the manufacturer. Hydrants shall be painted with one coat of red iron oxide, zinc oxide primer conforming to SSPC Paint 25 and two finish coats of silicone alkyd paint conforming to SSPC Paint 21, of the installation's standard colors or as directed by the Contracting Officer.

#### 2.7 MISCELLANEOUS ITEMS

##### 2.7.1 Service Clamps

Service clamps shall have a pressure rating not less than that of the pipe to be connected and shall be either the single or double flattened strap type. Clamps shall have a galvanized malleable-iron body with cadmium plated straps and nuts. Clamps shall have a rubber gasket cemented to the body.

##### 2.7.2 Corporation Stops

Corporation stops shall have standard corporation stop thread conforming to AWWA C800 on the inlet end, with flanged joints, compression pattern flared tube couplings, or wiped joints for connections to goosenecks.



### 2.7.3 Goosenecks

Copper tubing for gooseneck connections shall conform to the applicable requirements of ASTM B 88, Type K, annealed. Length of cable requirement connections shall be in accordance with standard practice.

### 2.7.4 Service Stops

Service stops shall be water-works inverted-ground-key type, oval or round flow way, tee handle, without drain. Pipe connections shall be suitable for the type of service pipe used. All parts shall be of bronze with female iron-pipe-size connections or compression-pattern flared tube couplings, and shall be designed for a hydrostatic test pressure not less than 1.375 MPa.

### 2.7.5 Tapping Sleeves

Tapping sleeves of the sizes indicated for connection to existing main shall be the cast gray, ductile, or malleable-iron, split-sleeve type with flanged or grooved outlet, and with bolts, follower rings and gaskets on each end of the sleeve. Construction shall be suitable for a maximum working pressure of 1.03 MPa. Bolts shall have square heads and hexagonal nuts. Longitudinal gaskets and mechanical joints with gaskets shall be as recommended by the manufacturer of the sleeve. When using grooved mechanical tee, it shall consist of an upper housing with full locating collar for rigid positioning which engages a machine-cut hole in pipe, encasing an elastomeric gasket which conforms to the pipe outside diameter around the hole and a lower housing with positioning lugs, secured together during assembly by nuts and bolts as specified, pretorqued to 67.8 Newton meters.

### 2.7.6 Service Boxes

Service boxes shall be cast iron or concrete and shall be extension service boxes of the length required for the depth of the line, with either screw or slide-type adjustment. The boxes shall have housings of sufficient size to completely cover the service stop or valve and shall be complete with identifying covers.

### 2.7.7 Disinfection

Chlorinating materials shall conform to the following:

Chlorine, Liquid: AWWA B301.

Hypochlorite, Calcium and Sodium: AWWA B300.

### 2.7.8 Meters

Meters shall be 75 mm and the type specified herein. Meters of each of the various types furnished and installed under this contract shall be supplied by one manufacturer.

#### 2.7.8.1 Turbine Type

Turbine type meters shall conform to AWWA C701. The main casing shall be bronze or cast iron protected by corrosion resistant coating with stainless

steel external fasteners. Registers shall be straight-reading type. Connections shall be suitable to the type of pipe and conditions encountered. Register type shall be a direct-reading remote register designed in accordance with AWWA C706 or an encoder-type remote register designed in accordance with AWWA C707. Meters shall comply with the accuracy and capacity requirements of AWWA C701.

#### 2.7.9 Meter Boxes

Meter boxes shall be of cast iron, concrete, or plastic. The boxes shall be of sufficient size to completely enclose the meter and shut-off valve or service stop. Meter boxes set in paved areas subject to vehicular traffic shall be cast iron, or concrete with cast iron lid and cast iron meter reader lid. Boxes set in sidewalks, not subject to vehicular traffic, shall be concrete with cast iron lid and cast iron meter reader lid. Plastic boxes and lids shall not be used. Box height shall extend from invert of the meter to final grade at the meter location. The lid shall have the word "WATER" cast in it.

### 3 EXECUTION

#### 3.1 INSTALLATION

##### 3.1.1 Cutting of Pipe

Cutting of pipe shall be done in a neat and workmanlike manner without damage to the pipe. Unless otherwise recommended by the manufacturer and authorized by the Contracting Officer, cutting shall be done with an approved type mechanical cutter. Wheel cutter shall be used when practicable. Copper tubing shall be cut square and all burrs shall be removed. Squeeze type mechanical cutters shall not be used for ductile iron.

##### 3.1.2 Adjacent Facilities

###### 3.1.2.1 Sewer Lines

Where the location of the water pipe is not clearly defined in dimensions on the drawings, the water pipe shall not be laid closer horizontally than 3 m from a sewer except where the bottom of the water pipe will be at least 300 mm above the top of the sewer pipe, in which case the water pipe shall not be laid closer horizontally than 1.8 m from the sewer. Where water lines cross under gravity-flow sewer lines, the sewer pipe for a distance of at least 3 m each side of the crossing shall be fully encased in concrete or shall be made of pressure pipe with no joint located within 900 mm horizontally of the crossing. Water lines shall in all cases cross above sewage force mains or inverted siphons and shall be not less than 600 mm above the sewer main. Joints in the sewer main, closer horizontally than 900 mm to the crossing, shall be encased in concrete.

###### 3.1.2.2 Water Lines

Water lines shall not be laid in the same trench with sewer lines, gas lines, fuel lines, or electric wiring.

### 3.1.2.3 Copper Tubing

Copper tubing shall not be installed in the same trench with ferrous piping materials.

### 3.1.2.4 Nonferrous Metallic Pipe

Where nonferrous metallic pipe, e.g. copper tubing, crosses any ferrous piping material, a minimum vertical separation of 300 mm shall be maintained between pipes.

### 3.1.2.5 Casing Pipe

Water pipe shall be encased in a sleeve of rigid conduit for the lengths shown. Where sleeves are required, the pipe sleeve shall be steel, manufactured in accordance with AWWA C200, ASTM A 36, with a minimum wall thickness of schedule 30 as specified for storm drains in Section 02720. A minimum clearance of at least 50 mm between the inner wall of the sleeve and the maximum outside diameter of the sleeved pipe and joints shall be provided. Sand bedding or suitable pipe support shall be provided for the water pipe through the sleeve. Sleeves of ferrous material shall be provided with corrosion protection as required in Section 16642.

### 3.1.2.6 Structures

Where water pipe is required to be installed within 1 m of existing structures, the water pipe shall be sleeved as required in Paragraph "Casing Pipe". The Contractor shall take proper precautions during installation of the water pipe and sleeve to ensure that there will be no damage to the structures and no settlement or movement of foundations or footings.

### 3.1.3 Joint Deflection

#### 3.1.3.1 Flexible Plastic Pipe

Maximum offset in alignment between adjacent pipe joints shall be as recommended by the manufacturer and approved by the Contracting Officer, but in no case shall it exceed 5 degrees.

#### 3.1.3.2 Ductile-Iron Pipe

The maximum allowable deflection shall be as given in AWWA C600. If the alignment requires deflection in excess of the above limitations, special bends or a sufficient number of shorter lengths of pipe shall be furnished to provide angular deflections within the limit set forth.

### 3.1.4 Placing and Laying

Pipe and accessories shall be carefully lowered into the trench by means of derrick, ropes, belt slings, or other authorized equipment. Under no circumstances shall any of the water-line materials be dropped or dumped into the trench. Care shall be taken to avoid abrasion of the pipe coating. Except where necessary in making connections with other lines or as authorized by the Contracting Officer, pipe shall be laid with the bells facing in the direction of laying. The full length of each section of pipe shall rest solidly upon the pipe bed, with recesses excavated to accommodate bells, couplings, and joints. Pipe that has the grade or joint disturbed

after laying shall be taken up and relaid. Pipe shall not be laid in water or when trench conditions are unsuitable for the work. Water shall be kept out of the trench until joints are complete. When work is not in progress, open ends of pipe, fittings, and valves shall be securely closed so that no trench water, earth, or other substance will enter the pipes or fittings. Where any part of the coating or lining is damaged, the repair shall be made by the Contractor at his expense in a satisfactory manner. Pipe ends left for future connections shall be valved, plugged, or capped, and anchored, as shown.

#### 3.1.4.1 Plastic Pipe Installation

PVC pipe shall be installed in accordance with AWWA M23.

#### 3.1.4.2 Connections

Where connections are made between new work and existing mains, the connections shall be made by using specials and fittings to suit the actual conditions. When made under pressure, these connections shall be installed using standard methods as approved by the Contracting Officer. Connections to existing asbestos-cement pipe shall be made in accordance with ACPPA-01.

#### 3.1.4.3 Penetrations

Pipe passing through walls of valve pits and structures shall be provided with ductile-iron or Schedule 40 steel wall sleeves. Annular space between walls and sleeves shall be filled with rich cement mortar. Annular space between pipe and sleeves shall be filled with mastic.

#### 3.1.4.4 Flanged Pipe

Flanged pipe shall only be installed above ground or with the flanges in valve pits.

#### 3.1.5 Jointing

##### 3.1.5.1 Polyvinyl Chloride (PVC) Plastic Pipe

- a. Pipe less than 100 mm diameter: Threaded joints shall be made by wrapping the male threads with approved thread tape or applying an approved lubricant, then threading the joining members together. The joint shall be tightened using strap wrenches to prevent damage to the pipe and/or fitting. To avoid excessive torque, joints shall be tightened no more than one thread past hand-tight. Preformed rubber-ring gaskets for elastomeric-gasket joints shall be made in accordance with requirements of ASTM F 477 and as required herein. All pipe ends for push-on joints shall be beveled to facilitate assembly and marked to indicate when the pipe is fully seated. The gasket shall be prelubricated to prevent displacement. The gasket and ring groove in the bell or coupling shall match. The manufacturer of the pipe or fitting shall supply the elastomeric gasket. Couplings shall be provided with stops or centering rings to assure that the coupling is centered on the joint. Solvent cement joints shall use sockets conforming to the requirements of ASTM D 2467. The solvent cement used shall meet the requirements of ASTM D 2564; the joint assembly shall be made

in accordance with ASTM D 2855 and the manufacturer's specific recommendations.

- b. Pipe 100 mm (4 inch) through 300 mm diameter: Joints shall be elastomeric-gasket as specified in AWWA C900. Jointing procedure shall be as specified for pipe less than 100 mm diameter with configuration using elastomeric ring gasket.
- c. Pipe 350 mm through 900 mm diameter: Joints shall be elastomeric-gasket push-on joints made in accordance with AWWA M23.

#### 3.1.5.2 Ductile-Iron Pipe

Mechanical and push-on type joints shall be installed in accordance with AWWA C600 for buried lines or AWWA C606 for grooved and shouldered pipe above ground or in pits.

#### 3.1.5.3 Copper Tubing

Joints shall be made with flared fittings. The flared end tube shall be pulled tightly against the tapered part of the fitting by a nut which is part of the fitting, so there is metal-to-metal contact.

#### 3.1.5.4 Bonded Joints

Bonded joints shall be installed in accordance with details specified for joints in paragraph JOINTS.

#### 3.1.5.5 Isolation Joints and Dielectric Fittings

Isolation joints and dielectric fittings shall be installed in accordance with details specified in paragraph JOINTS. Dielectric unions shall be encapsulated in a field-poured coal-tar covering, with at least 3 mm thickness of coal tar over all fitting surfaces.

#### 3.1.5.6 Connections

Connections between different types of pipe and accessories shall be made with transition fittings approved by the Contracting Officer.

#### 3.1.6 Service Lines

Service lines shall include the pipeline connecting building piping to water distribution lines to the connections with the building service at a point approximately 1.5 m outside the building where such building service exists. Where building services are not installed, the Contractor shall terminate the service lines approximately 1.5 m from the site of the proposed building at a point designated by the Contracting Officer. Such service lines shall be closed with plugs or caps. All service stops and valves shall be provided with service boxes. Service lines shall be constructed in accordance with the following requirements:

##### 3.1.6.1 Service Lines 50 mm and Smaller

Service lines 50 mm and smaller shall be connected to the main by a directly-tapped corporation stop or by a service clamp. A corporation stop and a copper gooseneck shall be provided with either type of connection.

Maximum sizes for directly-tapped corporation stops and for outlets with service clamps shall be as in TABLE I. Where 2 or more gooseneck connections to the main are required for an individual service, such connections shall be made with standard branch connections. The total clear area of the branches shall be at least equal to the clear area of the service which they are to supply.

TABLE I. SIZE OF CORPORATION STOPS AND OUTLET

Pipe Size mm (Inches)	Corporation Stops, mm	Outlets w/Service
	For Ductile-Iron Pipe	Clamps, mm
		Single & Double Strap
80	--	25
100	25	25
150	32	40
200	40	50
250	40	50
300 & larger	50	50

#### 3.1.6.2 Service Lines 40 mm and Smaller

Service lines 40 mm and smaller shall have a service stop.

#### 3.1.6.3 Service Lines 50 mm in Size

Service lines 50 mm in size shall have a gate valve.

#### 3.1.6.4 Service Lines Larger than 50 mm

Service lines larger than 50 mm shall be connected to the main by a tapped saddle, tapping sleeve and valve, service clamp or reducing tee, depending on the main diameter and the service line diameter, and shall have a gate valve. Lines 80 mm and larger may use rubber-seated butterfly valves as specified above, or gate valves.

#### 3.1.6.5 Service Lines for Sprinkler Supplies

Water service lines used to supply building sprinkler systems for fire protection shall be connected to the water distribution main in accordance with NFPA 24.

#### 3.1.7 Setting of Fire Hydrants, Meters, Valves and Valve Boxes

##### 3.1.7.1 Fire Hydrants

Fire hydrants shall be located and installed as shown. Each hydrant shall be connected to the main with a 150 mm branch line having at least as much

cover as the distribution main. Hydrants shall be set plumb with pumper nozzle facing the roadway, with the center of the lowest outlet not less than 450 mm above the finished surrounding grade, and the operating nut not more than 1.2 m above the finished surrounding grade. Fire hydrants designated on the drawings as low profile shall have the lowest outlet not less than 450 mm above the finished surrounding grade, the top of the hydrant not more than 600 mm above the finished surrounding grade. Except where approved otherwise, the backfill around hydrants shall be thoroughly compacted to the finished gradeline immediately after installation to obtain beneficial use of the hydrant as soon as practicable. The hydrant shall be set upon a slab of concrete not less than 100 mm thick and 400 mm square. Not less than 2 cubic meters of free-draining broken stone or gravel shall be placed around and beneath the waste opening of dry barrel hydrants to ensure drainage.

#### 3.1.7.2 Meters

Meters and meter boxes shall be installed at the locations shown on the drawings. The meters shall be centered in the boxes to allow for reading and ease of removal or maintenance.

#### 3.1.7.3 Valves

After delivery, valves, including those in hydrants, shall be drained to prevent freezing and shall have the interiors cleaned of all foreign matter before installation. Stuffing boxes shall be tightened and hydrants and valves shall be fully opened and fully closed to ensure that all parts are in working condition. Check, pressure reducing, vacuum, and air relief valves shall be installed in valve pits. Valves and valve boxes shall be installed where shown or specified, and shall be set plumb. Valve boxes shall be centered on the valves. Boxes shall be installed over each outside gate valve unless otherwise shown. Where feasible, valves shall be located outside the area of roads and streets. Earth fill shall be carefully tamped around each valve box or pit to a distance of 1.2 m on all sides of the box, or the undisturbed trench face if less than 1.2 m.

#### 3.1.7.4 Service Boxes

Where water lines are located below paved streets having curbs, the boxes shall be installed directly back of the curbs. Where no curbing exists, service boxes shall be installed in accessible locations, beyond the limits of street surfacing, walks and driveways.

#### 3.1.8 Tapped Tees and Crosses

Tapped tees and crosses for future connections shall be installed where shown.

#### 3.1.9 Thrust Restraint

Plugs, caps, tees and bends deflecting 11-1/4 degrees or more, either vertically or horizontally, on waterlines 100 mm in diameter or larger, and fire hydrants shall be provided with thrust restraints. Valves shall be securely anchored or shall be provided with thrust restraints to prevent movement. Thrust restraints shall be either thrust blocks or, for ductile-iron pipes, restrained joints.

### 3.1.9.1 Thrust Blocks

Thrust blocking shall be concrete of a mix not leaner than: 1 cement, 2-1/2 sand, 5 gravel; and having a compressive strength of not less than 14 MPa after 28 days. Blocking shall be placed between solid ground and the hydrant or fitting to be anchored. Unless otherwise indicated or directed, the base and thrust bearing sides of thrust blocks shall be poured directly against undisturbed earth. The sides of thrust blocks not subject to thrust may be poured against forms. The area of bearing shall be as shown or as directed. Blocking shall be placed so that the fitting joints will be accessible for repair. Steel rods and clamps, protected by galvanizing or by coating with bituminous paint, shall be used to anchor vertical down bends into gravity thrust blocks.

### 3.1.9.2 Restrained Joints

For ductile-iron pipe, restrained joints shall be designed by the Contractor or the pipe manufacturer in accordance with DIPRA-01.

## 3.2 HYDROSTATIC TESTS

Where any section of a water line is provided with concrete thrust blocking for fitting or hydrants, the hydrostatic tests shall not be made until at least 5 days after installation of the concrete thrust blocking, unless otherwise approved.

### 3.2.1 Pressure Test

After the pipe is laid, the joints completed, fire hydrants permanently installed, and the trench partially backfilled leaving the joints exposed for examination, the newly laid piping or any valved section of piping shall, unless otherwise specified, be subjected for 1 hour to a hydrostatic pressure test of 1.38 MPa. Each valve shall be opened and closed several times during the test. Exposed pipe, joints, fittings, hydrants, and valves shall be carefully examined during the partially open trench test. Joints showing visible leakage shall be replaced or remade as necessary. Cracked or defective pipe, joints, fittings, hydrants and valves, discovered in consequence of this pressure test shall be removed and replaced with sound material, and the test shall be repeated until the test results are satisfactory. The requirement for the joints to remain exposed for the hydrostatic tests may be waived by the Contracting Officer when one or more of the following conditions is encountered:

- a. Wet or unstable soil conditions in the trench.
- b. Compliance would require maintaining barricades and walkways around and across an open trench in a heavily used area that would require continuous surveillance to assure safe conditions.
- c. Maintaining the trench in an open condition would delay completion of the contract.

The Contractor may request a waiver, setting forth in writing the reasons for the request and stating the alternative procedure proposed to comply with the required hydrostatic tests. Backfill placed prior to the tests shall be placed in accordance with the requirements of Section 02222.



### 3.2.2 Leakage Test

Leakage test shall be conducted after the pressure tests have been satisfactorily completed. The duration of each leakage test shall be at least 2 hours, and during the test the water line shall be subjected to not less than 1.38 Mpa pressure. Leakage is defined as the quantity of water to be supplied into the newly laid pipe, or any valved or approved section thereof, necessary to maintain pressure within 34.5 kPa of the specified leakage test pressure after the pipe has been filled with water and the air expelled. No piping installation will be accepted if leakage exceeds the allowable leakage which is determined by the following formula:

$$L = 0.0001351ND(P \text{ raised to } 1/2 \text{ power})$$

L = Allowable leakage in gallons per hour

N = Number of joints in the length of pipeline tested

D = Nominal diameter of the pipe in inches

P = Average test pressure during the leakage test, in psi gauge

Should any test of pipe disclose leakage greater than that calculated by the above formula, the defective joints shall be located and repaired until the leakage is within the specified allowance, without additional cost to the Government.

### 3.2.3 Time for Making Test

Except for joint material setting or where concrete thrust blocks necessitate a 5-day delay, pipelines jointed with rubber gaskets, mechanical or push-on joints, or couplings may be subjected to hydrostatic pressure, inspected, and tested for leakage at any time after partial completion of backfill. Cement-mortar lined pipe may be filled with water as recommended by the manufacturer before being subjected to the pressure test and subsequent leakage test.

### 3.2.4 Concurrent Hydrostatic Tests

The Contractor may elect to conduct the hydrostatic tests using either or both of the following procedures. Regardless of the sequence of tests employed, the results of pressure tests, leakage tests, and disinfection shall be satisfactory as specified. All replacement, repair or retesting required shall be accomplished by the Contractor at no additional cost to the Government.

- a. Pressure test and leakage test may be conducted concurrently.
- b. Hydrostatic tests and disinfection may be conducted concurrently, using the water treated for disinfection to accomplish the hydrostatic tests. If water is lost when treated for disinfection and air is admitted to the unit being tested, or if any repair procedure results in contamination of the unit, disinfection shall be reaccomplished.

### 3.3 DISINFECTION

#### 3.3.1 Bacteriological Disinfection

Before acceptance of potable water operation, each unit of completed waterline shall be disinfected as prescribed by AWWA C651 or as specified herein. After pressure tests have been made, the unit to be disinfected shall be thoroughly flushed with water until all entrained dirt and mud have been removed before introducing the chlorinating material. The chlorinating material shall be either liquid chlorine, calcium hypochlorite, or sodium hypochlorite, conforming to paragraph MISCELLANEOUS ITEMS. The chlorinating material shall provide a dosage of not less than 50 ppm and shall be introduced into the water lines in an approved manner. Polyvinyl Chloride (PVC) pipe lines shall be chlorinated using only the above specified chlorinating material in solution. In no case will the agent be introduced into the line in a dry solid state. The treated water shall be retained in the pipe long enough to destroy all non-spore-forming bacteria. Except where a shorter period is approved, the retention time shall be at least 24 hours and shall produce not less than 25 ppm of free chlorine residual throughout the line at the end of the retention period. All valves on the lines being disinfected shall be opened and closed several times during the contact period. The line shall then be flushed with clean water until the residual chlorine is reduced to less than 1.0 ppm. During the flushing period, each fire hydrant on the line shall be opened and closed several times. From several points in the unit, personnel from the Contractor's commercial laboratory shall take at least 3 water samples from different points, approved by the Contracting Officer, in proper sterilized containers and perform a bacterial examination in accordance with state approved methods. The commercial laboratory must be certified by the state's approving authority for examination of potable water. The disinfection shall be repeated until tests indicate the absence of pollution for at least 2 full days. The unit will not be accepted until satisfactory bacteriological results have been obtained.

#### 3.3.2 Lead Residual

Following the bacteriological disinfection and testing, the system shall be flushed with a sufficient velocity of water and sufficient tests performed at each hot- and cold-water discharge point until no more than 15 ppb lead residuals remain in the system. All tests and samples shall be performed in accordance with state and, if applicable, Federal regulations. Samples for testing are to be collected after a 6-hour continuous period of no flushing, and will be considered first draw samples. The commercial laboratory must be certified by the state's approving authority for examination of potable water. Lead residual test results are to be submitted to the Contracting Officer. The system will not be accepted until satisfactory bacteriological results and lead residual test results have been obtained. All flushing and testing for lead residuals, including all costs, are the responsibility of the Contractor.

### 3.4 CLEANUP

Upon completion of the installation of water lines, and appurtenances, all debris and surplus materials resulting from the work shall be removed.



US Army Corps  
of Engineers  
Tulsa District

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Fort Sill, Oklahoma

# **Whole Barracks Complex Renewal**

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## SECTION 02685

## GAS DISTRIBUTION SYSTEM

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN GAS ASSOCIATION (AGA)

AGA-01 (1989) A.G.A. Plastic Pipe Manual for Gas Service

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI B109.2 (1992) Diaphragm Type Gas Displacement Meters (Over 500 Cubic Feet per Hour Capacity)

## AMERICAN PETROLEUM INSTITUTE (API)

API Spec 5L (1995) Line Pipe

API Spec 6D (1994; Supple June 1996) Pipeline Valves, (Gate, Plug, Ball, and Check Valves)

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 53 (1996) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

ASTM A 181 (1995b) Forgings, Carbon Steel, for General-Purpose Piping

ASTM D 2513 (1995c) Thermoplastic Gas Pressure Pipe, Tubing, and Fittings

ASTM D 2683 (1993) Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing

ASTM D 3261 (1993) Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing

ASTM D 3308 (1991a) PTFE Resin Skived Tape

ASTM D 3350 (1993) Polyethylene Plastics Pipe and Fittings Materials

## AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1 (1983; R 1992) Pipe Threads, General Purpose (Inch)

ASME B16.5	(1988; Errata Oct 1988; B16.5a) Pipe Flanges and Flanged Fittings
ASME B16.9	(1993) Factory-Made Wrought Steel Buttwelding Fittings
ASME B16.11	(1991) Forged Fittings, Socket-Welding and Threaded
ASME B16.21	(1992) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.34	(1988) Valves - Flanged, Threaded, and Welding End
ASME B31.8	(1995) Gas Transmission and Distribution Piping Systems

## CODE OF FEDERAL REGULATIONS (CFR)

49 CFR 192	Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards
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## MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(1993) Standard Marking System for Valves, Fittings, Flanges and Unions
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## NACE INTERNATIONAL (NACE)

NACE RP0185	(1985) Extruded, Polyolefin Resin Coating Systems for Underground or Submerged Pipe
NACE RP0274	(1993) High Voltage Electrical Inspection of Pipeline Coatings Prior to Installation

## STEEL STRUCTURES PAINTING COUNCIL (SSPC)

SSPC Paint 25	(1991) Red Iron Oxide, Zinc Oxide, Raw Linseed Oil and Alkyd Primer (Without Lead and Chromate Pigments)
SSPC Paint 104	(1991) White or Tinted Alkyd Paint
SSPC SP 1	(1982) Solvent Cleaning
SSPC SP 3	(1995) Power Tool Cleaning
SSPC SP 6	(1994) Commercial Blast Cleaning
SSPC SP 7	(1994) Brush-Off Blast Cleaning

## UNDERWRITERS LABORATORIES (UL)

UL-06	(1996) Gas and Oil Equipment Directory
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## 1.2 GENERAL REQUIREMENTS

### 1.2.1 Jointing Polyethylene Piping

Piping shall be joined by performance qualified joiners using qualified procedures in accordance with AGA-01. Manufacturer's prequalified joining procedures shall be used. Joints shall be inspected by an inspector qualified in the joining procedures being used and in accordance with AGA-01. Joiners and inspectors shall be qualified at the jobsite by a person who has been trained and certified by the manufacturer of the pipe, to train and qualify joiners and inspectors in each joining procedure to be used on the job. Training shall include use of equipment, explanation of the procedure, and successfully making joints which pass tests specified in AGA-01. The Contracting Officer shall be notified at least 24 hours in advance of the date to qualify joiners and inspectors.

### 1.2.2 Standard Products

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Asbestos or products containing asbestos shall not be used. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site. Valves, flanges, and fittings shall be marked in accordance with MSS SP-25.

### 1.2.3 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

### 1.2.4 Handling

Pipe and components shall be handled carefully to ensure a sound, undamaged condition. Particular care shall be taken not to damage pipe coating. No pipe or material of any kind shall be placed inside another pipe or fitting after the coating has been applied, except as specified in paragraph INSTALLATION. Plastic pipe shall be handled in conformance with AGA-01.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

SD-04 Drawings

Pipe, Fittings, and Associated Materials; GA.

Drawings shall contain complete schematic and piping diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage of the system and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

## SD-07 Schedules

Equipment and Materials; GA.

A complete list of equipment and materials, including manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts, and installation instructions, including, but not limited to the following:

- a. Dielectric Unions and Flange Kits.
- b. Meters.
- c. Pressure Reducing Valves.
- d. Regulators.
- e. Emergency Gas Supply Connection.

Spare Parts Data; FIO.

Spare parts lists for each different item of material and equipment specified, after approval of the detail drawings and not later than 2 months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

Notification; GA.

Notification of the Contractor's schedule for making connections to existing gas lines, at least 10 days in advance.

## SD-08 Statements

Welding Steel Piping; FIO.

A copy of qualified welding procedures along with a list of names and identification symbols of performance qualified welders and welding operators.

Jointing Polyethylene Piping; GA.

A copy of qualified jointing procedures, training procedures, qualifications of trainer, and training test results for joiners and inspectors.

Connection and Abandonment Procedures; GA.

A copy of procedures for gas line tie in, hot taps, abandonment/removal or demolition, purging, and plugging as applicable in accordance with ASME B31.8.

## SD-13 Certificates

Utility Work; FIO.

Certification from the Operating Agency/Utility Company that work for which the Utility is responsible has been completed.

Training; FIO.

A copy of each inspector's and jointer's training certificate with respective test results.

## SD-19 Operation and Maintenance Manuals

Gas Distribution System; FIO.

Six copies, in booklet form and indexed, of site specific natural gas operation and maintenance manual for each gas distribution system including system operation, system maintenance, equipment operation, and equipment maintenance manuals described below. If operation and maintenance manuals are provided in a common volume, they shall be clearly differentiated and separately indexed.

The System Operation Manual shall include but not be limited to the following:

- a. Maps showing piping layout and locations of all system valves and gas line markers.
- b. Step-by-step procedures required for system startup, operation, and shutdown. System components and equipment shall be indexed to the gas maps.
- c. Isolation procedures and valve operations to shut down or isolate each section of the system. Valves and other system components shall be indexed to the gas maps.
- d. Descriptions of Site Specific Standard Operation Procedures including permanent and temporary pipe repair procedures, system restart and test procedures for placing repaired lines back in service, and procedures for abandoning gas piping and system components.
- e. Descriptions of Emergency Procedures including: isolation procedures including required valve operations with valve locations indexed to gas map, recommended emergency equipment, checklist for major emergencies and procedures for connecting emergency gas supply.

The Equipment Operation Manual shall include but not be limited to detail drawings, equipment data, and manufacturer supplied operation manuals for all equipment, valves and system components.

The System Maintenance Manuals shall include but not be limited to:

- a. Maintenance check list for entire gas distribution system.



- b. Descriptions of site specific standard maintenance procedures.
- c. Maintenance procedures for installed cathodic protection systems.
- d. Piping layout, equipment layout, and control diagrams of the systems as installed.
- e. Identification of pipe materials and manufacturer by location, pipe repair procedures, and jointing procedures at transitions to other piping materials or piping from different manufacturer.

The Equipment Maintenance Manuals shall include but not be limited to the following:

- a. Identification of valves and other equipment by materials, manufacturer, vendor identification and location.
- b. Maintenance procedures and recommended maintenance tool kits for all valves and equipment.
- c. Recommended repair methods, either field repair, factory repair, or whole-item replacement for each valve component or piece of equipment or component item.
- d. Routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide.

## 2 PRODUCTS

### 2.1 PIPE, FITTINGS, AND ASSOCIATED MATERIALS

Underground pipe shall be polyethylene. Aboveground pipe shall be steel.

#### 2.1.1 Steel Pipe

Steel pipe shall conform to ASTM A 53, Grade A or B, Type E or S, Schedule 40; or API Spec 5L seamless or electric resistance welded, Schedule 40, black steel pipe as specified in ASME B31.8. Furnace butt welded pipe may be used in sizes 40 mm (1-1/2 inches) and smaller.

#### 2.1.2 Small Fittings

Fittings 40 mm and smaller shall conform to ASME B16.11.

#### 2.1.3 Fittings, 50 mm and Larger

Pipe flanges and flanged fittings including bolts, nuts, and bolt patterns shall be in accordance with ASME B16.5. Buttweld fittings shall be in accordance with ASME B16.9. Weld neck flanges shall be used.

#### 2.1.4 Steel Forged Branch Connections

Connections shall conform to ASTM A 181, Class 60, carbon steel.

#### 2.1.5 Flange Gaskets

Gaskets shall be non-asbestos compressed material in accordance with ASME B16.21, 1.6 mm minimum thickness, full face or self-centering flat ring type. The gaskets shall contain aramid fibers bonded with nitrile butadiene rubber (NBR), or glass fibers bonded with polytetrafluorethylene, suitable for maximum 315 degrees C service and meeting applicable requirements of ASME B31.8.

#### 2.1.6 Pipe Threads

Pipe threads shall conform to ASME B1.20.1.

#### 2.1.7 Polyethylene Pipe, Tubing, Fittings and Joints

Polyethylene pipe, tubing, fittings and joints shall conform to ASTM D 3350 and ASTM D 2513, pipe designations PE 2406 and PE 3408, rated SDR 11 or less, as specified in ASME B31.8. Pipe sections shall be marked as required by ASTM D 2513. Butt fittings shall conform to ASTM D 3261 and socket fittings shall conform to ASTM D 2683. Fittings shall match the service rating of the pipe.

#### 2.1.8 Sealants for Steel Pipe Threaded Joints

##### 2.1.8.1 Sealing Compound

Joint sealing compound shall be as listed in UL-06, Class 20 or less.

##### 2.1.8.2 Tape

Polytetrafluoroethylene tape shall conform to ASTM D 3308.

#### 2.1.9 Identification

Pipe flow markings and metal tags for each valve, meter, and regulator shall be provided as required by the Contracting Officer.

#### 2.1.10 Insulating Joint Materials

Insulating joint materials shall be provided between flanged or threaded metallic pipe systems where shown to isolate galvanic or electrolytic action.

##### 2.1.10.1 Threaded Joints

Joints for threaded pipe shall be steel body nut type dielectric type unions with insulating gaskets.

##### 2.1.10.2 Flanged Joints

Joints for flanged pipe shall consist of full face sandwich-type flange insulating gasket of the dielectric type, insulating sleeves for flange bolts and insulating washers for flange nuts.

### 2.1.11 Gas Transition Fittings

Gas transition fittings shall be manufactured steel fittings approved for jointing steel and polyethylene or fiberglass pipe. Approved transition fittings are those that conform to AGA-01 requirements for transition fittings.

## 2.2 VALVES

Valves shall be suitable for shutoff or isolation service and shall conform to the following:

### 2.2.1 Steel Valves

Steel valves 40 mm and smaller installed underground shall conform to ASME B16.34, carbon steel, socket weld ends, with "high head" square wrench operator adaptor extension. Steel valves 40 mm and smaller installed aboveground shall conform to ASME B16.34, carbon steel, socket weld or threaded ends with handwheel or wrench operator. Steel valves 50 mm and larger installed underground shall conform to API Spec 6D, carbon steel, butt-welded ends with square wrench operator adaptor. Steel valves 50 mm and larger installed aboveground shall conform to API Spec 6D, carbon steel, butt-welded or flanged ends, with handwheel or wrench operator.

## 2.3 PRESSURE REGULATORS

Regulators shall have ferrous bodies, shall provide backflow and vacuum protection, and shall be designed to meet the pressure, load and other service conditions.

### 2.3.1 Service Line Regulators

Pressure regulators for individual service lines shall have ferrous bodies. Regulator shall be capable of reducing distribution line pressure to pressures required for users. Regulators shall be provided where gas will be distributed at pressures in excess of 2.5 kPa. Pressure relief shall be set at a lower pressure than would cause unsafe operation of any connected user. Regulator shall have single port with orifice diameter no greater than that recommended by the manufacturer for the maximum gas pressure at the regulator inlet. Regulator valve vent shall be of resilient materials designed to withstand flow conditions when pressed against the valve port. Regulator shall be capable of regulating downstream pressure within limits of accuracy and shall be capable of limiting the buildup of pressure under no-flow conditions to 50 percent or less of the discharge pressure maintained under flow conditions. Regulator shall have a self-contained service regulator. Regulator pipe connections shall not exceed 50 mm (2 inch) size.

## 2.4 METERS

Meters shall conform to ANSI B109.2. Meters shall be pipe or pedestal mounted. Meters shall be provided with over-pressure protection as specified in ASME B31.8, tamper-proof protection, and frost protection. Meters shall be suitable for accurately measuring and handling gas at pressures, temperatures, and flow rates indicated. Meters shall have a pulse switch initiator capable of operating up to speeds of 500 pulses per minute with no false pulses and shall require no field adjustments.

Initiators shall provide the maximum number of pulses up to 500 per minute that is obtainable from the manufacturer. It shall provide not less than one pulse per 2.83 cubic meter of gas.

## 2.5 PROTECTIVE COVERING MATERIALS

### 2.5.1 Thermoplastic Resin Coating System

Continuously extruded polyethylene and adhesive coating system materials shall conform to NACE RP0185, Type A.

## 3 EXECUTION

### 3.1 EXCAVATION AND BACKFILLING

Earthwork shall be as specified in Section 02222.

### 3.2 GAS MAINS

Pipe for gas mains shall be polyethylene. Polyethylene mains shall not be installed aboveground.

### 3.3 SERVICE LINES AND EMERGENCY GAS SUPPLY CONNECTION

Service lines shall extend from a gas main to and including the point of delivery within 1.5 meters of the building. The point of delivery is the meter set assembly. The service lines shall be connected to the gas mains through service tees, with end of run plugged. Where indicated, service line shall be provided with an isolation valve of the same size as the service line. The service lines shall be as short and as straight as practicable between the point of delivery and the gas main and shall not be bent or curved laterally unless necessary to avoid obstructions or otherwise permitted. Service lines shall be laid with as few joints as practicable using standard lengths of pipe. Shorter lengths shall be used only for closures. Polyethylene service lines shall not be installed aboveground except as permitted in ASME B31.8.

### 3.4 WORKMANSHIP AND DEFECTS

Pipe, tubing, and fittings shall be clear and free of cutting burrs and defects in structure or threading and shall be thoroughly brushed and blown free of chips and scale. Defective pipe, tubing, or fittings shall be replaced and shall not be repaired.

### 3.5 PROTECTIVE COVERING

#### 3.5.1 Protective Covering for Underground Steel Pipe

Except as otherwise specified, protective coverings shall be applied mechanically in a factory or field plant especially equipped for the purpose. Valves and fittings that cannot be coated and wrapped mechanically shall have the protective covering applied by hand, preferably at the plant that applies the covering to the pipe. Joints shall be coated and wrapped by hand. Hand coating and wrapping shall be done in a manner and with materials that will produce a covering equal in thickness to that of the covering applied mechanically.

#### 3.5.1.1 Thermoplastic Resin Coating System

The coating system shall conform to NACE RP0185, Type A. The exterior of the pipe shall be cleaned to a commercial grade blast cleaning finish in accordance with SSPC SP 6. Adhesive compound shall be applied to the pipe. Immediately after the adhesive is applied, a seamless tube of polyethylene shall be extruded over the adhesive to produce a bonded seamless coating. The nominal thickness of the pipe coating system shall be 0.25 mm (plus or minus 10 percent) of adhesive and 1.0 mm (plus or minus 10 percent) of polyethylene for pipes up to 400 mm in diameter. For pipes 450 mm and larger in diameter, the pipe coating system thickness shall be 0.25 mm (plus or minus 10 percent) adhesive and 1.5 mm (plus or minus 10 percent) polyethylene. Joint coating and field repair material shall be applied as recommended by the coating manufacturer and shall be one of the following:

- a. Heat shrinkable polyethylene sleeves.
- b. Polyvinyl chloride pressure-sensitive adhesive tape.
- c. High density polyethylene/bituminous rubber compound tape.

The coating system shall be inspected for holes, voids, cracks, and other damage during installation.

#### 3.5.1.2 Inspection of Pipe Coatings

Any damage to the protective covering during transit and handling shall be repaired before installation. After field coating and wrapping has been applied, the entire pipe shall be inspected by an electric holiday detector with impressed current set at a value in accordance with NACE RP0274 using a full-ring, spring-type coil electrode. The holiday detector shall be equipped with a bell, buzzer, or other type of audible signal which sounds when a holiday is detected. All holidays in the protective covering shall be repaired immediately upon detection. The Contracting Officer reserves the right to inspect and determine the suitability of the detector. Labor, materials, and equipment necessary for conducting the inspection shall be furnished by the Contractor.

#### 3.5.2 Protective Covering for Aboveground Piping Systems

Finish painting shall conform to the applicable paragraphs of Section 09900. and as follows:

##### 3.5.2.1 Ferrous Surfaces

Shop primed surfaces shall be touched up with ferrous metal primer same type paint as the shop primer. Surfaces that have not been shop primed shall be solvent-cleaned in accordance with SSPC SP 1. Surfaces that contain loose rust, loose mill scale, and other foreign substances shall be mechanically cleaned by power wire brushing in accordance with SSPC SP 3 or brush-off blast cleaned in accordance with SSPC SP 7 and primed with ferrous metal primer in accordance with SSPC Paint 25. Primed surfaces shall be finished with two coats of exterior alkyd paint conforming to SSPC Paint 104.

### 3.5.3 Protective Covering for Piping in Valve Boxes and Manholes

Piping in valve boxes or manholes shall receive protective coating as specified for underground steel pipe.

## 3.6 INSTALLATION

Gas distribution system and equipment shall be installed in conformance with the manufacturer's recommendations and applicable sections of ASME B31.8, AGA-01 and 49 CFR 192. Existing gas lines shall be removed or abandoned as indicated. Abandoned gas lines shall be filled with grout. Abandoning existing gas piping shall be done in accordance with ASME B31.8. Pipe shall be cut without damaging the pipe. Unless otherwise authorized, cutting shall be done by an approved type of mechanical cutter. Wheel cutters shall be used where practicable. On steel pipe 150 mm, an approved gas-cutting-and-beveling machine may be used. Cutting of plastic pipe shall be in accordance with AGA-01. Valve installation in plastic pipe shall be designed to protect the plastic pipe against excessive torsional or shearing loads when the valve is operated and from other stresses which may be exerted through the valve or valve box.

### 3.6.1 Installing Pipe Underground

Gas mains and service lines shall be graded as indicated. Mains shall have 600 mm minimum cover; service lines shall have 485 mm minimum cover; and both mains and service lines shall be placed on firmly compacted select material for the full length. Where indicated, the main shall be encased, bridged, or designed to withstand any anticipated external loads as specified in ASME B31.8. The encasement material shall be standard weight black steel pipe with a protective coating as specified. The pipe shall be separated from the casing by insulating spacers and sealed at the ends with casing bushings. Trench shall be excavated below pipe grade, bedded with bank sand, and compacted to provide full-length bearing. Laying the pipe on blocks to produce uniform grade will not be permitted. The pipe shall be clean inside before it is lowered into the trench and shall be kept free of water, soil, and all other foreign matter that might damage or obstruct the operation of the valves, regulators, meters, or other equipment. When work is not in progress, open ends of pipe or fittings shall be securely closed by expandable plugs or other suitable means. Minor changes in line or gradient of pipe that can be accomplished through the natural flexibility of the pipe material without producing permanent deformation and without overstressing joints may be made when approved. Changes in line or gradient that exceed the limitations specified shall be made with fittings. When cathodic protection is furnished, electrically insulated joints or flanges shall be provided. When polyethylene piping is installed underground, foil backed magnetic tape shall be placed above the pipe to permit locating with a magnetic detector. After laying of pipe and testing, trench shall be backfilled in accordance with Section 02222.

### 3.6.2 Installing Pipe Aboveground

Aboveground piping shall be protected against dirt and other foreign matter as specified for underground piping. Joints in steel pipe shall be welded; however joints in pipe 40 mm in diameter and smaller may be threaded; joints may also be threaded to accommodate the installation of valves. Flanges shall be of the weld neck type to match wall thickness of pipe.

### 3.7 PIPE JOINTS

Pipe joints shall be designed and installed to effectively sustain the longitudinal pullout forces caused by the contraction of piping or superimposed loads.

#### 3.7.1 Threaded Steel Joints

Threaded joints in steel pipe shall have tapered threads evenly cut and shall be made with UL approved graphite joint sealing compound for gas service or polytetrafluoroethylene tape applied to the male threads only. Caulking of threaded joints to stop or prevent leaks will not be permitted.

#### 3.7.2 Welded Steel Joints

Gas pipe weldments shall be as indicated. Changes in direction of piping shall be made with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be permitted. Branch connection may be made with either welding tees or forged branch outlet fittings. Branch outlet fittings shall be forged, flared for improvement of flow where attached to the run, and reinforced against external strains. Beveling, alignment, heat treatment, and inspection of weld shall conform to ASME B31.8. Weld defects shall be removed and repairs made to the weld, or the weld joints shall be entirely removed and rewelded. After filler metal has been removed from its original package, it shall be protected or stored so that its characteristics or welding properties are not affected adversely. Electrodes that have been wetted or have lost any of their coating shall not be used.

#### 3.7.3 Polyethylene Pipe Jointing Procedures

Jointing procedures shall conform to AGA-01. Indiscriminate heat fusion joining of plastic pipe or fittings made from different polyethylene resins by classification or by manufacturer shall be avoided if other alternative jointing procedures are available. If heat fusion joining of dissimilar polyethylenes is required, special procedures are required. The method of heat fusion joining dissimilar polyethylene resins shall be tested in accordance with paragraph TESTS, subparagraph Destructive Tests of Plastic Pipe Joints.

#### 3.7.4 Connections Between Metallic and Plastic Piping

Connections shall be made only outside, underground, and with approved transition fittings.

### 3.8 VALVE BOXES

Valve boxes of cast iron not less than 4.7 mm thick shall be installed at each underground valve except where concrete or other type of housing is indicated. Valve boxes shall be provided with locking covers that require a special wrench for removal. Wrench shall be furnished for each box. The word "gas" shall be cast in the box cover. When the valve is located in a roadway, the valve box shall be protected by a suitable concrete slab at least 1 square meter. When in a sidewalk, the top of the box shall be in a concrete slab 600 mm square and set flush with the sidewalk. Boxes shall be adjustable extension type with screw or slide-type adjustments. Valve boxes shall be separately supported, not resting on the pipe, so that no traffic

loads can be transmitted to the pipe. Valves shall only be located in valve boxes or inside of buildings.

### 3.9 PRESSURE REGULATOR INSTALLATION

#### 3.9.1 Service Line Regulators

A shutoff valve, meter set assembly, and service regulator shall be installed on the service line outside the building, 450 mm above the ground on the riser. An insulating joint shall be installed on the inlet side of the meter set assembly and service regulator and shall be constructed to prevent flow of electrical current. A 10 mm tapped fitting equipped with a plug shall be provided on both sides of the service regulator for installation of pressure gauges for adjusting the regulator. All service regulator vents and relief vents shall terminate in the outside air in rain and insect resistant fittings. The open end of the vent shall be located where gas can escape freely into the atmosphere, away from any openings into the building and above areas subject to flooding.

### 3.10 METER INSTALLATION

Meters shall be installed in accordance with ASME B31.8. Permanent gas meters shall be installed with provisions for isolation and removal for calibration and maintenance, and shall be suitable for operation in conjunction with an energy monitoring and control system.

### 3.11 CONNECTIONS TO EXISTING LINES

Connections between new work and existing gas lines, where required, shall be made in accordance with ASME B31.8 using proper fittings to suit the actual conditions. When connections are made by tapping into a gas main, the connecting fittings shall be the same size as the pipe being connected.

#### 3.11.1 Connection to Government Owned/Operated Gas Lines

The Contractor shall provide connections to the existing gas lines in accordance with approved procedures. Deactivation of any portion of the existing system shall only be done with the approval of the Contracting Officer. Reactivation of any existing gas lines will only be done by the Government. The Contractor's Connection and Abandonment Plan shall be submitted and approved prior to making any connections to existing gas lines. This plan shall include the Operating Agency's required procedures which may be obtained from DPW. The Contractor shall notify the Contracting Officer, in writing, 10 days before connections to existing lines are to be made.

- a. If facilities are abandoned in place, they shall be physically disconnected from the piping system. The open ends of all abandoned facilities shall be purged and filled with grout. Abandonment shall not be completed until it has been determined that the volume of gas or liquid hydrocarbons contained within the abandoned section poses no potential hazard. Air or inert gas may be used for purging, or the facility may be filled with water or other inert material. If air is used for purging, the Contractor shall ensure that a combustible mixture is not present after purging.



- b. All abovegrade valves, risers, and vault and valve box covers shall be removed. Vault and valve box voids shall be filled with suitable compacted backfill material.

### 3.12 TESTS

#### 3.12.1 Destructive Tests of Plastic Pipe Joints

Each day, prior to making polyethylene heat fusion joints or fiberglass adhesive joints, a joint of each size and type to be installed that day shall be made by each person performing joining of plastic pipe that day and destructively tested. At least 3 longitudinal straps shall be cut from each joint. Each strap shall be visually examined, shall not contain voids or discontinuities on the cut surfaces of the joint area, and shall be deformed by bending, torque, or impact, and if failure occurs, it must not initiate in the joint area. If a joint fails the visual or deformation test, the qualified joiner who made that joint shall not make further field joints in plastic pipe on this job until that person has been retrained and requalified. The results of the destructive tests shall be recorded to include the date and time of the tests, size and type of the joints, ambient conditions, fusion iron temperature and names of inspectors and joiners.

#### 3.12.2 Pressure and Leak Tests

The system of gas mains and service lines shall be tested after construction and before being placed in service using air as the test medium. The normal operating pressure for the system is 345 kPa. The test pressure is 517 kPa. Prior to testing the system, the interior shall be blown out, cleaned and cleared of all foreign materials. All meters, regulators, and controls shall be removed before blowing out and cleaning and reinstalled after clearing of all foreign materials. Testing of gas mains and service lines shall be done with due regard for the safety of employees and the public during the test. Persons not working on the test operations shall be kept out of the testing area while testing is proceeding. The test shall be made on the system as a whole or on sections that can be isolated. Joints in sections shall be tested prior to backfilling when trenches must be backfilled before the completion of other pipeline sections. The test shall continue for at least 24 hours from the time of the initial readings to the final readings of pressure and temperature. The initial test readings of the instrument shall not be made for at least 1 hour after the pipe has been subjected to the full test pressure, and neither the initial nor final readings shall be made at times of rapid changes in atmospheric conditions. The temperatures shall be representative of the actual trench conditions. There shall be no indication of reduction of pressure during the test after corrections have been made for changes in atmospheric conditions in conformity with the relationship  $T(1)P(2)=T(2)P(1)$ , in which T and P denote absolute temperature and pressure, respectively, and the numbers denote initial and final readings. During the test, the entire system shall be completely isolated from all compressors and other sources of air pressure. Each joint shall be tested by means of soap and water or an equivalent nonflammable solution prior to backfilling or concealing any work. The testing instruments shall be approved by the Contracting Officer. All labor, materials and equipment for conducting the tests shall be furnished by the Contractor and shall be subject to inspection at all times during the tests. The Contractor shall maintain safety precautions for air pressure testing at all times during the tests.

## SECTION 02698

## PREFABRICATED UNDERGROUND HEATING/COOLING DISTRIBUTION SYSTEM

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 53	(1995b) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 105	(1996) Forgings, Carbon Steel, for Piping Components
ASTM A 106	(1994) Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A 234	(1996b) Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM C 518	(1991) Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM C 591	(1994) Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM D 5686	(1995) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Pipe Fittings, Adhesive Bonded Joint Type Epoxy Resin, for Condensate Return Lines

## AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(1983; R 1992) Pipe Threads, General Purpose (Inch)
ASME B16.9	(1993) Factory-Made Wrought Steel Buttwelding Fittings
ASME B16.11	(1991) Forged Fittings, Socket-Welding and Threaded
ASME B31.1	(1995) Power Piping
ASME BPV IX	(1995; Addenda Dec 1995) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications

## COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA-02

(1995) Copper Tube Handbook

## 1.2 SYSTEM DESCRIPTION

The system consists of a buried prefabricated chilled water and low temperature hot water distribution system including service connections to a point 150 mm inside of the building. The contract drawings show the specific arrangement of piping, sizes and grades of pipe, and other details. The system is designed for an operating pressure of 413.7 kPa and an operating temperature of 87.8 degrees C for hot water and 5.6 degrees C for chilled water.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330.

## SD-01 Data

Distribution System; GA.

Data composed of catalog cuts, brochures, circulars, specifications and product data, and printed information in sufficient detail and scope to verify compliance with the requirements of the contract documents.

## SD-04 Drawings

Distribution System; GA.

Detail drawings consisting of fabrication and assembly drawings, for all parts of the work in sufficient detail to check conformity with the requirements of the contract documents, prior to installation. Detail drawings shall also contain complete piping, wiring and schematic diagrams and any other details to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout, method of compensation for pipe expansion and contraction, anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances required for maintenance and operation. The drawings shall clearly identify any proposed deviations from the requirements of the contract documents.

## SD-13 Certificates

Distribution System; FIO.

The manufacturer's or system fabricator's written certification stating that the distribution system furnished meets all the requirements of this specification.

Welding Procedures and Operators; FIO.

Prior to welding operations, a copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators.

## SD-19 Operation and Maintenance Manuals

Distribution System; FIO.

Six copies of operation and six copies of maintenance manuals for the equipment furnished, one complete set prior to performance testing and the remainder upon acceptance. Operation manuals shall detail the step-by-step procedures required for equipment startup, operation, and shutdown. Operation manuals shall include the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features. Maintenance manuals shall list routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Maintenance manuals shall include piping and equipment layout and simplified wiring and control diagrams of the equipment system as installed. Manuals shall be approved prior to the field performance testing.

## 1.4 DELIVERY AND STORAGE

After delivery to the jobsite, all materials and equipment shall be protected from anything which could cause damage to the material or equipment. All pipe shall be sealed at each end to keep the interior clean and free of dirt and debris. Fittings shall be kept together and their interior surfaces shall remain clean. Any insulation shall be kept dry and clean.

## 1.5 FIELD MEASUREMENTS

The Contractor shall become familiar with all details of the work, verify all dimensions in the field and shall advise the Contracting Officer of any discrepancy before performing the work.

## 1.6 WELDING

Piping shall be welded in accordance with qualified procedures using performance qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPV IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified 24 hours in advance of tests and the tests shall be performed at the work site if practicable. The welder or welding operator shall apply his assigned symbol near each weld he makes as a permanent record.

## 2 PRODUCTS

## 2.1 STANDARD PRODUCTS

System components shall be standard products of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. The system shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

## 2.2 PIPING AND CASING MATERIALS

### 2.2.1 General

Metallic pressure pipe, fittings, and piping accessories shall conform to the requirements of ASME B31.1 and shall be types suitable for the temperature and pressure of the water. The prefabricated piping system shall consist of a steel carrier pipe, polyurethane foam insulation and outer pipe of reinforced thermosetting resin pipe (RTRP).

### 2.2.2 Piping

#### 2.2.2.1 Steel Pipe (Carrier Pipe)

Piping shall conform to ASTM A 53, Grade B, standard weight, black or to ASTM A 106, Grade B, standard weight.

### 2.2.3 Casings

#### 2.2.3.1 Reinforced Thermosetting Resin Pipe (RTRP) Casing

RTRP casing shall be of the same material as designated for the pipe with casing thickness as follows:

Casing Diameter (in mm)	Minimum Thickness (in mm)
200	1.78
250	2.03
300	2.67
350	2.92
400 to 450	3.05
500	3.18
600	3.94

## 2.3 PIPING CONNECTIONS

### 2.3.1 Steel Pipe

Steel pipe smaller than 20 mm may be threaded, otherwise, all steel pipe shall be welded. Steel welding fittings shall conform to the requirements of ASTM A 105 or ASTM A 234. Welding fittings shall also conform to ASME B16.9 for butt-weld fittings and ASME B16.11 for socket-weld fittings. Long radius butt-welding elbows conforming to ASME B16.9 shall be used whenever space permits. Pipe Threads shall conform to ASME B1.20.1. Pipe to be threaded shall be schedule 80.

### 2.3.2 Plastic Pipe

- a. Pipe, fittings, flanges, and couplings shall have end connections of the adhesive bell and spigot type. Threaded piping, including pipe, fittings, flanges, and couplings, will not be permitted.
- b. Flanged Connections: Flat face flanged connections shall be provided between plastic piping and metal piping. Plastic flanges shall be suitable for connection to ASME Class 150 flanges.

- c. RTRP Piping Sizes: When piping sizes other than 50, 75, 100, 150, and 200 mm are indicated, the next larger piping size shall be provided. The connecting system piping shall be of the same size or increased to meet the next size of RTRP piping.

#### 2.3.2.1 General

Plastic fittings shall be made of the same type and grade of material as the piping to which they will be connected and shall be furnished by the manufacturer who supplies the pipe. Fittings shall have temperature and pressure ratings not less than those of the connecting piping.

#### 2.3.2.2 Reinforced Thermosetting Resin Plastic (RTRP)

Reinforced thermosetting resin plastic pipe shall be joined using fittings and adhesive furnished by the pipe manufacturer in accordance with ASTM D 5686.

### 2.4 END SEALS

#### 2.4.1 General

Each preinsulated section of piping shall have a complete sealing of the insulation to provide a permanent water and vapor seal at each end of the preinsulated section of piping. Preinsulated sections of piping modified in the field shall be provided with an end seal which is equivalent to the end seals furnished with the preinsulated section of piping. End seals must be tested and certified in accordance with paragraph Casing and End Seal Testing and Certification.

#### 2.4.2 Types

End seals provided shall be one of the following types:

- a. Carrying the outer casing over tapered pipe insulation ends and extending it to the carrier pipe. Sufficient surface bonding area shall be provided between the casing and the carrier pipe.
- b. Using specially designed molded caps made of polyethylene or rubber of standard manufactured thickness. A minimum 40 mm surface bonding area shall be provided between the cap and both the casing and carrier pipe.
- c. Using elastomer-ring end seals designed and dimensioned to fit in the annular space between the casing and the carrier pipe.
- d. Using a waterproof mastic seal vapor barrier over the exposed insulation ends.
- e. Shrink sleeves.

#### 2.4.3 Casing and End Seal Testing and Certification

Testing and certification procedures by an independent testing laboratory shall demonstrate that casings and end seals are capable of resisting penetration of water into the casing and insulation. The test shall be performed on the type of prefabricated system to be furnished. If more than

one type of prefabricated system is to be used, then the tests shall be performed on each type. The test shall consist of hot and cold cycle testing followed by immersion in a water filled chamber with a head pressure. The hot and cold cycle testing shall consist of 14 days of temperature cycling. A fluid with a temperature of 5 degrees C shall circulate through the carrier pipe alternating every 24-hours with a fluid with a temperature of 95 degrees C circulating through the carrier pipe for a low temperature hot water or dual temperature service or 24 degrees for a chilled water service. While the hot and cold cycle test is being performed, the test sample is either buried or encased in dry bedding sand with a minimum of 300 mm of sand all around the test sample. The carrier pipe size of the test sample shall be 80 mm (3 inches) in diameter and shall be restrained during the test period. The insulation thickness shall not exceed the maximum thickness provided for the piping in the project. Transition time for temperature cycle testing shall not exceed 15 minutes in going from cold to hot and 30 minutes in going from hot to cold. The fluid in the carrier pipe may be water, oil or heat transfer fluid. Following the hot and cold cycling test, the test sample shall be immersed in a water filled chamber. The pressure on the highest point of the test sample shall not be less than 60 kPa subjected over the entire length of the 2.4 m test sample of prefabricated pipe. The water shall contain a dye penetrant, which will be used to check for end seal leakage. The pressure in the chamber must be held for not less than 48 hours. Upon completion of this pressure test, the test sample shall be cut open. With the use of a light that will readily show the presence of the dye that was in the water, the test sample shall be inspected. Evidence of the dye inside the test sample shall indicate that the end seal is not acceptable and cannot be certified. A pipe manufacturer who has a current Federal Letter of Acceptability for a system furnished under this section will be exempt from the testing specified in this paragraph.

## 2.5 INSULATION

### 2.5.1 Factory Applied Insulation

Prefabricated pipe and fittings shall be insulated in the factory. Foam insulation for prefabricated insulated pipe and fittings shall be polyurethane foam meeting the requirements of ASTM C 591 having a density not less than 32 kg per cubic meter. The polyurethane foam shall completely fill the annular space between the carrier pipe and the casing. Insulation thickness shall be a minimum of 20 mm. The insulation thermal conductivity factor shall not exceed the numerical value of 0.02 W/mK at 24 degrees C, when tested in accordance with ASTM C 518. Manufacturer shall certify that the insulated pipe is free of insulation voids.

### 2.5.2 Field Applied Insulation

Field applied insulation for fittings, and field casing closures, if required, and other piping system accessories shall be polyurethane matching the pipe insulation. Thickness shall match adjacent piping insulation thickness. Buried fittings and accessories shall have field applied polyurethane insulation to match adjacent piping and shall be protected with a covering matching the pipe casing. Shrink sleeves with a minimum thickness of 1.27 mm shall be provided over casing connection joints.

## 2.6 CONCRETE VALVE MANHOLES

Concrete valve manholes shall be provided in accordance with Section 02699.

## 2.7 PIPING AND EQUIPMENT IN VALVE MANHOLES

Piping and equipment in valve manholes shall be provided in accordance with Section 02699.

# 3 EXECUTION

## 3.1 INSTALLATION

For all preinsulated, prefabricated systems, the Contractor shall obtain the services of a trained representative of the pipe system manufacturer to instruct the Contractor's work forces in the installation procedures to ensure that the system is installed in accordance with the manufacturer's PUBLISHED instructions and the plans and specifications. The manufacturer's representative shall be a person who regularly performs such duties for the manufacturer. The Contractor shall furnish the Contracting Officer a list of names of personnel trained and certified by the pipe system manufacturer in the installation of this system. Only personnel whose names appear on the list will be allowed to install the system. The list shall not be more than 1 year old.

## 3.2 PIPING SYSTEMS

### 3.2.1 Buried Insulated Systems

Buried insulated systems shall consist of carrier pipe, insulation, casing, end seals, fittings and accessories as specified.

## 3.3 VALVE MANHOLES AND PIPING EQUIPMENT IN VALVE MANHOLES

Valve manholes and piping and equipment in valve manholes shall be installed in accordance with Section 02699.

## 3.4 THRUST BLOCKS

Thrust blocks shall be installed at the locations shown or recommended by the pipe system manufacturer. Thrust blocks may not be required on all systems, and the need for thrust blocks shall be as recommended by the system manufacturer. Thrust blocks, if necessary, shall be installed at all changes in direction, changes in size, valves and terminal ends, such as plugs, caps and tees. Thrust blocks shall be concrete having a compressive strength of not less than 14 MPa after 28 days and shall be in accordance with Section 03300. Thrust blocks shall be placed between solid ground and the fitting to be anchored. Unless otherwise indicated or directed, the base and the thrust bearing sides of the thrust blocks shall be poured directly against undisturbed earth. The sides of the thrust blocks not subject to thrust may be poured against forms. Thrust blocks shall be placed so that the joints for all fittings will be accessible for repair wherever possible. No pipe joint shall be embedded in concrete unless the assembly has previously been hydrostatically tested. The thrust blocks shall provide for transfer of thrusts and reactions without exceeding the allowable stress of the concrete and shall be installed in accordance with pipe manufacturer's instructions. In muck or peat, all thrusts shall be



resisted by piles or tie rods to solid foundations or by removal of peat or muck which shall be replaced with ballast of sufficient stability to resist thrusts.

### 3.5 INSTALLATION OF PIPING SYSTEMS

The piping system furnished shall be installed in accordance with the piping system manufacturer's instructions. Piping shall be installed without springing or forcing other than what has been calculated for cold spring. Pipe ends shall have burrs removed by reaming and shall be installed to permit free expansion and contraction without damage to joints or hangers. Nonmetallic pipe cut in the field shall be machined to fit couplings or joints and shall be coated or treated to match standard factory coated ends. Copper tubing shall not be installed in the same trench with ferrous piping materials. When nonferrous metallic pipe (e.g., copper tubing) crosses any ferrous piping material, a minimum vertical separation of 300 mm shall be maintained between pipes. Connections between different types of pipe and accessories shall be made with transition fittings approved by the manufacturer of the piping system.

#### 3.5.1 Pitching of Horizontal Piping

Horizontal piping shall be pitched at a grade of not less than 40 mm in 1 m toward the drain points unless otherwise indicated.

#### 3.5.2 Open Ends

Open ends of pipelines and equipment shall be properly capped or plugged during installation to keep dirt and other foreign matter out of the system.

#### 3.5.3 Cutting Prefabricated Piping Sections

Where prefabricated pipe sections are field cut, new end seals similar to the factory applied end seal shall be provided and installed in accordance with the manufacturer's instructions.

#### 3.5.4 Joints

##### 3.5.4.1 Welded Joints

Welded joints between sections of pipe and between pipe and fittings shall be provided where specified or indicated.

##### 3.5.4.2 Threaded Joints

Threaded joints shall not be used belowground. Joints shall be made tight with polytetrafluoroethylene tape applied to the male threads only. Not more than three threads shall show after the joint is made up.

##### 3.5.4.3 Brazed Joints

Brazed joints for copper pipe and fittings shall conform to CDA-02. Brazing alloys melting above 593.3 degrees C shall be utilized.

#### 3.5.4.4 Nonmetallic Pipe Joints

Nonmetallic pipe joints shall be installed in accordance with the written instructions of the manufacturer.

#### 3.5.5 Expansion Loops

Expansion loops shall be factory fabricated of casing, insulation, and carrier piping identical to that furnished for straight runs. Loops shall be properly designed in accordance with the allowable stress limits indicated in ASME B31.1 for the type of pipe used. Loops shall be shipped to the jobsite in the maximum size sections feasible to minimize the number of field joints. The loop casing and insulation where applicable, shall be suitably sized to accommodate pipe movement. Field joints shall be made in straight runs of the loops and the number shall be kept to a minimum. For steel pipe, cold springing shall not be allowed when sizing the expansion loops, but piping shall be cold sprung one-half the calculated maximum operational expansion during field assembly. L- and Z-bends shall conform to the requirements for expansion loops specified in ASME B31.1.

#### 3.5.6 Anchors

Anchor design shall be in accordance with the published data of the manufacturer and for prefabricated systems shall be factory fabricated by the prefabricated system manufacturer. In all cases, the design shall be such that water penetration, condensation, or vapor transmission will not wet the insulation.

#### 3.5.7 Field Casing Closures

Field insulation and encasement of joints shall be accomplished after the visual and pressure tests specified are completed. Field insulation and encasement shall be in accordance with the manufacturer's written instructions. Thickness dimensions of the insulation and casing materials shall not be less than those of the adjoining prefabricated section. Insulating material shall be foamed in place polyurethane. Care should be taken to ensure that field closures are made under conditions of temperature and cleanliness required to produce a sound, continuous vapor barrier. A standard polyethylene heat shrink sleeve shall be installed over the casing and shall have a 150 mm minimum overlap at each end.

#### 3.5.8 Underground Warning Tape

Underground warning tape shall be buried above the piping during the trench backfilling and shall be buried approximately 300 mm deep. Tape shall be 0.1 mm thick polyethylene tape. Tape shall be 150 mm wide and be printed with repetitive caution warnings along its length. Tapes shall be yellow in color with black letters. Tape color and lettering shall not be affected by moisture or other substances contained in the backfill material.

#### 3.5.9 Markers for Underground Piping

Underground cable shall be provided longitudinal to all nonmetallic piping systems. Such cable shall be sized so as to allow identification of each pipe and be in accordance with Corps of engineers and Ft. Sill requirements.

### 3.6 EARTHWORK

Earthwork shall be performed in accordance with Section 02222.

### 3.7 ELECTRICAL WORK

Electrical work shall be performed in accordance with either Section 16375 or Section 16370.

### 3.8 TESTING

Tests shall be conducted before, during, and after installation of the system. All instruments, equipment, facilities, and labor required to properly conduct the tests shall be provided by the Contractor. Test pressure gauges for a specific test shall have dials indicating not less than 1-1/2 times nor more than 2 times the test pressure. It shall be the Contractor's responsibility to make the pipe system workable at his expense.

#### 3.8.1 Metallic Pipe Welds

An approved independent testing firm or firms regularly engaged in radiographic testing shall perform a radiographic examination of the field welds. The radiographic testing shall be performed in accordance with ASME B31.1. All radiographs shall be reviewed and interpreted by a Certified Level III Radiographer employed by the testing firm. Any welds found to be unacceptable shall be removed, rewelded and radiographically reexamined in accordance with the above criteria. Such repair and reexamination shall be accomplished at no cost to the Government.

#### 3.8.2 Carrier Pipe Testing

Distribution piping shall be tested as required before backfilling and with all joints exposed. The area between joints may be backfilled as necessary to prevent pipe movement.

##### 3.8.2.1 Cleaning Carrier Pipe

Prior to testing, the interior of the carrier pipe shall be cleaned of all foreign materials by thorough flushing with clean water. Water shall be circulated at a velocity between 2 and 3 m/s for a minimum of 4 hours. If required, temporary and/or supplementary pumps shall be provided to ensure that required velocity is achieved. Any system strainers shall be cleaned after the flushing operation is complete. Temporary strainers shall be installed as required. After flushing, the water will remain in the piping system for testing of the system. All air must be removed from the system prior to starting the tests.

##### 3.8.2.2 Hydrostatic Pressure Cycling and Tests

Hydrostatic pressure cycling will have four cycles. Each cycle shall consist of a 10 minute period at 1035 kPa followed by a 5 minute period at a pressure less than 345 kPa. The next cycle will begin immediately following the completion of the previous cycle. Pressure rise and drop shall not exceed 689.5 kPa per minute. The pressure gauge shall be located and the pressure measured at the opposite end of the system from where the pressure is applied. After completion of the hydrostatic pressure cycling the first hydrostatic pressure test shall be performed. During the first hydrostatic

pressure test the system shall be proven tight at a pressure of 1-1/2 times the working pressure up to 1035 kPa. This pressure shall be held for a minimum of 1 hour. The method of pressurizing the system shall be disconnected from the system before starting the 1 hour pressure holding period. If the pressure cannot be held for the specified length of time, the cause of pressure loss shall be determined, corrected and the hydrostatic pressure cycling and first hydrostatic pressure test shall be repeated until the system can hold the required pressure for at least 1 hour.

#### 3.8.2.3 Operational Test

Operational test shall be performed on the complete system or testable portions thereof. The test shall be conducted with full design flows and operating temperatures in all runs of piping as if in service, to demonstrate satisfactory function and operating effectiveness. The operational test will have two cycles. Each cycle shall consist of a 6-hour period with treated water in the system at the maximum operating temperature of 82 degrees C and maximum flow rate and a period of at least 6 hours with no flow. For dual temperature systems, the first cycle shall use the heating temperature of 82 degrees C and the second cycle the cooling temperature of 6 degrees C of the designed system. The Contractor shall supply temporary pumps, piping connections, boilers, chillers and the gauges required to circulate the water at the desired temperatures and flow rates. Water shall be circulated through supply lines and returned through the return piping to demonstrate that the pressure drop is compatible with the flow rate and size of pipe and to show that obstructions do not exist in the piping system. Any unusual indicated pressure drop will be investigated and any obstructions removed. Any leaks found shall be repaired. After any obstructions have been removed and any leaks repaired, the operational test shall be repeated until successfully passed.

#### 3.8.2.4 Final Hydrostatic Test

After successful completion of the operational test, the system shall be pressurized to 1-1/2 times the working pressure up to 1000 kPa. This pressure shall be held for a minimum of 4 hours. The method of pressurizing the system shall be disconnected from the system prior to the start of the 4-hour pressure holding period. If the pressure cannot be held for the specified length of time, the cause of the pressure loss shall be determined, corrected, and all of the hydrostatic pressure cycling and tests repeated.

## SECTION 02699

## VALVE MANHOLES AND PIPING AND EQUIPMENT IN VALVE MANHOLES

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designations only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI H35.1 (1993) Alloy and Temper Designation Systems for Aluminum

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 53 (1995a) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

ASTM A 106 (1994) Seamless Carbon Steel Pipe for High-Temperature Service

ASTM A 193 (1996) Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service

ASTM A 194 (1996) Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service

ASTM A 234 (1996b) Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures

ASTM A 733 (1993) Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples

ASTM B 209 (1996) Aluminum and Aluminum-Alloy Sheet and Plate

ASTM C 449 (1995) Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement

ASTM C 647 (1989a) Properties and Tests of Mastics and Coating Finishes for Thermal Insulation

ASTM C 533 (1985; R 1990) Calcium Silicate Block and Pipe Thermal Insulation

ASTM C 547 (1995) Mineral Fiber Pipe Insulation

ASTM C 552 (1991) Cellular Glass Thermal Insulation

ASTM D 3278	(1989) Test Methods for Flash Point of Liquids by Setaflash Closed-Cup Apparatus
ASTM E 84	(1996a) Surface Burning Characteristics of Building Materials
ASTM E 96	(1995) Water Vapor Transmission of Materials

## AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(1983; R 1992) Pipe Threads, General Purpose (Inch)
ASME B16.5	(1988, Errata Oct 88; B16.5a) Pipe Flanges and Flanged Fittings
ASME B16.9	(1993) Factory-Made Wrought Steel Buttwelding Fittings
ASME B16.11	(1991) Forged Fittings, Socket-Welding and Threaded
ASME B16.21	(1992) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.34	(1988) Valves - Flanged, Threaded, and Welding End
ASME B31.1	(1995) Power Piping
ASME B40.1	(1991) Gauges - Pressure Indicating Dial Type - Elastic Element
ASME BPV IX	(1995; Addenda Dec 1995) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications

## MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(1993) Standard Marking System for Valves, Fittings, Flanges, and Unions
MSS SP-45	(1992) By Pass and Drain Connections
MSS SP-58	(1993) Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-69	(1996) Pipe Hangers and Supports - Selection and Application
MSS SP-72	(1992) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-80	(1987) Bronze Gate, Globe, Angle and Check Valves

MSS SP-83 (1995) Class 3000 Steel Pipe Unions Socket-Welding and Threaded

MSS SP-110 (1996) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (1996) National Electrical Code

NFPA 90A (1993) Installation of Air Conditioning and Ventilating Systems

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

SSPC Paint 16 (1991) Coal-Tar Epoxy-Polyamide Black (or Dark Red) Paint

SSPC SP 10 (1994) Near-White Blast Cleaning

UNDERWRITERS LABORATORIES (UL)

UL 723 (1996) Test for Surface Burning Characteristics of Building Materials

## 1.2 DESCRIPTION

This specification covers valve manholes and the valves and equipment shown in the manholes on the drawings.

## 1.3 SUBMITTALS

Government approval is required for submittals having a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300.

### SD-04 Drawings

Valve Manholes, Pipe, and Equipment; GA.

Detail drawings for valve manholes and the piping and equipment in the valve manholes, such as steam traps, valves, sump pumps, pressure gauges, thermometers and insulation, including a complete list of equipment and materials, including manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts, and installation instructions. Drawings shall also contain complete wiring and schematic diagrams. Drawings shall show pipe anchors and guides, and layout and anchorage of equipment and appurtenances in valve manholes, and equipment relationship to other parts of the work including clearances for maintenance and operation.

### SD-14 Samples

Insulated Sections; GA.

Display sample sections for insulation of pipe, elbow, tee, valve, support point, and terminating points. After approval of materials and prior to

insulation of piping, a display shall be prepared of insulated sections showing compliance with specifications including showing fastening, sealing, jacketing, straps, waterproofing, supports, hangers, anchors, and saddles. Approved display sample sections shall remain on display at the jobsite during the construction period until no longer needed by Contracting Officer, then removed.

#### SD-19 Operation and Maintenance Manuals

Valve Manholes, Pipe, and Equipment; FIO.

Six copies of operation and six copies of maintenance manuals are required for the equipment furnished. Operation manuals shall detail the step-by-step procedures required for equipment startup, operation, and shutdown. Operation manuals shall include the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features. Maintenance manuals shall list routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Maintenance manuals shall include piping and equipment layout and simplified wiring and control diagrams indicating location of electrical components with terminals designated for wiring, as installed.

#### 1.4 DELIVERY AND STORAGE

All materials and equipment delivered and placed in storage shall be stored with protection from the weather, excessive humidity and excessive temperature variation; and dirt, dust, or other contaminants.

#### 1.5 FIELD MEASUREMENTS

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

### 2 PRODUCTS

#### 2.1 STANDARD PRODUCTS

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

#### 2.2 NAMEPLATES

Each major item of equipment such as sump pumps, motors, steam traps, and pressure reducing valves shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

#### 2.3 ASBESTOS PROHIBITION

Asbestos and asbestos-containing products shall not be used.



## 2.4 ELECTRICAL WORK

Motors, manual or automatic motor control equipment, and protective or signal devices required for the operation specified shall be provided under this section in accordance with NFPA 70 and Section 16375.

## 2.5 PIPING AND FITTINGS

### 2.5.1 General

Piping, fittings and piping accessories inside the valve manholes shall conform to the requirements of ASME B31.1 and shall be suitable for the working pressure and temperature requirements of the system. To the greatest extent possible, the piping and fittings inside the valve manholes shall match the piping and fittings located on the outside of the valve manhole. All piping in valve manholes shall be steel with joints welded except that joints 20 mm and smaller may be threaded. When threaded joints are used on High Temperature Water Systems, the interface area where the pipe threads meet the threaded fittings shall be seal welded (continuous fillet weld) to preclude any water leakage. No supports, anchors, or stays shall be attached to any piping system in places where either the installation of or the movement of the pipe and its contents will cause damage to the construction.

### 2.5.2 Steel Pipe

Pipe shall be black steel, seamless or electric-resistance welded, conforming to the requirements of ASTM A 53, Grade B or ASTM A 106, Grade B. Pipe up to and including 250 mm in diameter shall be schedule 40. Pipe 300 mm in diameter and greater shall be 10 mm nominal wall thickness. Gauge piping, condensate piping, drip piping, and piping 20 mm in diameter and smaller shall be schedule 80.

#### 2.5.2.1 Nipples

Nipples shall conform to ASTM A 733 as required to match adjacent piping.

#### 2.5.2.2 Pipe Threads

Pipe threads shall conform to ASME B1.20.1. Pipe threads may be used only on pipe 20 mm or smaller. All pipe which is to be threaded shall be schedule 80.

### 2.5.3 Fittings

All fittings, valves, flanges and unions shall have the manufacturer's trademark affixed in accordance with MSS SP-25 so as to permanently identify the manufacturer.

#### 2.5.3.1 Welded Fittings

Welded fittings shall conform to ASTM A 234, buttwelded or socket welded, as required to match connecting piping. Buttwelded fittings shall conform to ASME B16.9, and socket welded fittings shall conform to ASME B16.11.

#### 2.5.3.2 Unions

Unions shall conform to MSS SP-83 as required to match adjacent piping.

#### 2.5.3.3 Ball Valves

Ball valves shall conform to MSS SP-72 for flanged or butt welded valves or MSS SP-110 for threaded ball valves.

#### 2.5.4 Insulating Flanges and Dielectric Unions

##### 2.5.4.1 Insulating Flanges

For systems in which cathodic protection is provided, insulating flanges or flange gasket kits shall be installed in the valve manhole at the pipe connection to or from the heat distribution system and at dissimilar metals and when the carrier pipe and appurtenances are supported in such a way as to electrically ground or alter the cathodic protection system voltages or currents. The kit shall consist of flanges, a flange gasket, nuts and bolts, bolt sleeves and one insulating washer and one steel washer for both ends of each bolt. The manufacturer shall certify that the gasket kits are capable of electrically isolating the pipe at the 551.6 kPa pressure and 71.1 degrees C temperature of the heating medium at the point of application. Evidence of satisfactory installations operating not less than 2 years shall be submitted in accordance with Section 02698, Paragraph 1.3, and SD-13 Certificates before materials are delivered. The Contractor shall ensure that these kits are provided and properly installed according to manufacturer published instructions. Care shall be taken to torque the bolts to the correct tightness and in the correct bolt pattern as recommended by the manufacturer's published instructions. Steel flanges shall conform to ASME B16.5 Class 150 or 300 and shall match valves or flanged fittings on which used. Steel flanges shall be flat faced. Gaskets shall be non-asbestos compressed material in accordance with ASME B16.21, 2 mm thickness, full face or self centering flat ring type. Bolts shall conform to the requirements of ASTM A 193, Grade B7. The bolt head shall be marked to identify the manufacturer and shall be marked to identify the standard to which the bolt complies. Lengths of bolts shall be such that not less than two full threads extend beyond the nut with the bolt tightened to the required tension and the washer seated. Nuts shall conform to the requirements of ASTM A 194, Grade 7.

##### 2.5.4.2 Dielectric Unions

Dielectric unions, pressure rated to match the pressure on the system used, shall be used for joining dissimilar metals on 20 mm (3/4 inch) and smaller threaded pipe.

#### 2.6 VALVES

Unless otherwise specified, valves shall comply with the material, fabrication, and operating requirements of ASME B31.1. Valves shall be suitable for the temperature and pressure requirements of the system on which used. Valves for hot water shall conform to ASME B31.1 Class 150 or 300 as suitable for the application. Valves 20 mm and smaller may be bronze where seal welding is not required. Valves 150 mm and larger shall have a 25 mm minimum gate or globe bypass valve sized in conformance with MSS SP-45.

### 2.6.1 Steel Valves

Steel globe, gate, angle, and check valves shall conform to the requirements of ASME B16.34 and ASME B31.1 for the temperature and pressure requirements of the system. Gate valves 65 mm and smaller shall be rising stem. Gate valves 80 mm and larger shall be outside screw and yoke.

### 2.6.2 Bronze Valves

#### 2.6.2.1 Globe, Gate, and Angle Valves

Bronze globe, gate, and angle valves shall conform to requirements of MSS SP-80, union bonnet type.

#### 2.6.2.2 Check Valves

Bronze check valves shall conform to the requirements of MSS SP-80.

### 2.6.3 Packing

Packing used with valves shall not contain asbestos. Valve stem packing shall be die-formed, ring type specifically designated as suitable for the temperature and pressure of the service and compatible with the fluid in the system. Packing shall be polytetrafluoroethylene with minimum 50 percent graphite filament. Valves 40 mm and smaller shall have four or five packing rings and valves 50 mm and larger shall have at least six packing rings. Spiral or continuous packing will not be acceptable. A metal insert shall be provided having proper clearance around the valve stem at the bottom of the stuffing box and acting as a base for the packing material. Packing glands shall be furnished with a liner of noncorrosive material and shall be of one piece construction with provisions for not less than two bolts for packing adjustment.

## 2.7 STRAINERS

Strainers shall be basket or y-type with connections the same size as the pipe lines in which the connections are installed. The strainer bodies for steam systems shall be heavy and durable, of cast steel, with bottoms drilled and plugged. The strainers shall be suitable for the temperature and pressure requirements of the system on which they are installed. The bodies shall have arrows clearly cast on the sides to indicate the direction of flow. Each strainer shall be equipped with an easily removable cover and sediment basket. The body or bottom opening shall be equipped with nipple and gate valve for blowdown. The basket for steam systems shall be not less than 0.6350 mm thick stainless steel, Monel or sheet brass, with small perforations of sufficient number to provide a net free area through the basket of at least 2.5 times that of the entering pipe. The flow shall be into the basket and out through the perforations. For high temperature hot water systems, only cast steel bodies and stainless or Monel baskets shall be used.

## 2.8 PRESSURE GAUGES

Gauges shall conform to ASME B40.1 and shall be provided with throttling type needle valve or a pulsation dampener and shut-off valve. Minimum dial size shall be 108 mm.

## 2.9 DIAL THERMOMETERS

Dial type thermometer shall be 89 mm in diameter with stainless steel case, remote-type bulb or direct-type bulb as required. The thermometer shall have an accuracy of plus or minus .56 degree C. Thermometer wells of the separable socket type shall be provided for each thermometer with direct-type bulb. The thermometer shall have a white face with black digits graduated in 1 degree C increments.

## 2.10 INSULATION AND JACKETING

### 2.10.1 General

All piping, fittings, valves, etc. in the valve manholes shall be insulated. Insulation shall be premolded, precut or job fabricated to fit and shall be removable and reusable. Thickness of insulation shall be in accordance with Tables 1 and 2. Insulation jackets shall be provided for all pipe and fitting insulation.

### 2.10.2 Insulation

Insulation for all piping, fittings, and valves shall be molded calcium silicate conforming to ASTM C 533, Type I, or molded mineral fiber insulation conforming to ASTM C 547, Class 2 or cellular glass insulation conforming to ASTM C 552. All insulation shall be asbestos free. The insulation shall be approved by the Federal Agency Committee on Underground Heat Distribution Systems as having passed their boiling test. Laminated construction shall not be used unless the thickness exceeds 100 mm. Manufacturer's and their calcium silicate and mineral fiber insulation products passing the Federal Agency Committee's boiling test and approved for use are:

- a. Fibrex Inc., Epitherm 1200 (Dark).
- b. Owens-Corning Fiberglass Corporation, Kaylo 10.
- c. Manville Products Group, Thermo-12.
- d. Partek Insulations, Limited, Paroc UHDS.
- e. Pabco, division of Fibreboard Corporation, Super Caltemp.
- f. Delta, Rock Wool Manufacturing Company.
- g. Cellular Glass, Pittsburgh Corning Corporation.

### 2.10.3 Aluminum Jackets

Aluminum jackets shall be smooth sheet, 0.4064 mm nominal thickness and conform to the requirements of ASTM B 209, Type 3003, 3105, or 5005. Aluminum jackets shall be supplied with a factory installed moisture barrier. This moisture barrier shall consist of at least 18.1 kg kraft paper coated on one side with a 0.025 mm thick polyethylene film. The moisture barrier shall be adhered to the aluminum jacket over the entire area of the aluminum jacket surface.

#### 2.10.4 Bands

Bands for aluminum jacket shall be 9.53 mm wide and 32 gauge thickness made of aluminum or annealed stainless steel. Bands for insulation shall be 13 mm wide and 32 gauge thickness made of annealed stainless steel.

#### 2.10.5 Insulation for Flanges, Unions, Valves, and Fittings

Flanges, unions, valves, and fittings shall be insulated with premolded prefabricated, or field fabricated segments of insulation of the same material and thickness as the manhole pipe insulation. Insulation shall be removable and reusable and shall have essentially the same thermal characteristics and thickness as the adjoining piping.

#### 2.10.6 Vapor Barrier Coating

The vapor barrier coating shall be fire and water resistant and appropriately selected for either outdoor or indoor service. Color shall be white. The water vapor permeance of the compound shall not exceed 0.05 perm and shall be determined according to procedure B of ASTM E 96. The coating shall be a nonflammable, fire resistant type conforming to ASTM E 84, NFPA 90A and UL 723. The flash point of the compound shall not be less than 26.7 degrees C and shall be determined in accordance with ASTM D 3278. All other application and service properties shall be in accordance with ASTM C 647.

#### 2.10.7 Finishing Cement

Mineral fiber hydraulic-setting thermal insulating cement ASTM C 449.

#### 2.10.8 Glass Tape

Glass tape shall meet the requirements of UL 723 and ASTM E 84.

#### 2.10.9 Plain Weave, Untreated

The ends shall be properly interlocked with the picks to ensure that there shall be no raveling of the tape edges. It shall have an average weight of 196.7 plus or minus 10 percent grams per square meter. An average thickness of .178 plus or minus .025 mm. Warp ends/wales of 16.5 plus or minus 1 per centimeter or filling picks/courses of 1.26 plus or minus 1 per centimeter, a minimum breaking strength of 26.82 kilograms per cm of width, and after heating to 482.2 degrees C for 2 hours. A minimum breaking strength of 7.152 kilograms per cm of width.

#### 2.10.10 Knitted, Untreated

The wales shall be properly interlocked with the courses to ensure that there shall be no raveling of the tape edges. It shall have an average weight of 153 plus or minus 10 percent grams per square meter. An average thickness of .1778 plus or minus .0254 mm, warp ends/wales of 6 plus or minus per 1 centimeter. A minimum breaking strength of 714 grams per mm of width and, after heating to 482 degrees C for 2 hours. A minimum breaking strength of 375 grams per mm of width.

#### 2.10.11 Distortion Requirements

There shall be no distortion of the tape when a sample 610 mm in length is spread across a flat horizontal surface and observed for evidence of distortion (such as tendency to curl rather than lie flat). The width tolerance is plus or minus 3.175 mm.

#### 2.10.12 Open-Weave Type

Tape shall be open-weave type and shall have an average weight of 1.11 kg per square meter and shall be used for embedding between coats of adhesive or coating materials.

### 2.11 CONCRETE VALVE MANHOLES AND ACCESSORIES

#### 2.11.1 Valve Manhole Construction

Valve manhole dimensions shall be as indicated. The valve manholes shall be constructed of reinforced concrete as indicated and in accordance with Section 03300. Valve manholes shall be provided with a 762 mm standard cast iron frame and removable cover as a minimum or a 900 mm by 900 mm watertight, hinged steel cover not less than 12.7 mm thick. Valve manholes shall be drained as shown. Concrete sections shall not be less than 150 mm thick. The top shall be solid plate cover (8 mm ) thick checker pattern) conforming to ANSI H35.1. When used for concrete shallow trenches, the top of the grate will be flush with the concrete trench top. Open grates will be constructed of galvanized steel. A checkered plate cover (also referred to as diamond plate or embossed plate), shall be installed over the grating in colder climates and where accumulation of trash is a problem. This checkered plate shall be attached to the grating and shall be removable.

Valve manhole sides shall be constructed by one monolithic pour and shall extend not less than 6 inches above grade unless otherwise stated. Valve manholes shall be waterproofed in accordance with Section 07111. All steel components shall be protected from corrosion.

#### 2.11.2 Pipe Sleeves

Pipe sleeves of sufficient length to pass through valve manhole or building walls shall be provided. Pipe sleeves shall be zinc-coated steel pipe conforming to the requirement of ASTM A 53, Schedule 40 or standard weight. The pipe sleeves shall be secured in the proper position and location during construction of the valve manhole or building wall. For manhole top penetrations, the diameter of the pipe sleeve will be large enough to allow at least 6 mm of clearance between the pipe insulation and the sleeve, and, the sleeve will be sized to accommodate the specific mechanical seal size used for the penetration. The space between the sleeve and the pipe casing, and the caulking and sealing materials shall be selected so that there shall be NO electrical continuity between the pipe sleeve and the pipe casing when finished.

#### 2.11.3 Pipe Supports

Pipe Supports shall be in accordance with MSS SP-58 and MSS SP-69, type as shown. All pipe supports, including structural cross support members, shall be galvanized in accordance with Section 05500. Chains, straps, or single point supports shall not be used.

## 2.12 MISCELLANEOUS METAL

Miscellaneous metal not otherwise specified shall conform to Section 05500. Miscellaneous metal bolted together, shop welded, or assembled in the field, and pipe supports including structural cross support members and anchors shall be hot-dip galvanized in accordance with Section 05500.

## 3 EXECUTION

### 3.1 SITE WORK

#### 3.1.1 Excavation, Trenching, and Backfilling

Excavation, trenching, and backfilling of the valve manholes shall be as shown and in accordance with Section 02222.

#### 3.1.2 Electric Work

Any wiring required for the operation of the equipment specified, but not shown on the electrical drawings, shall be provided under this section in accordance with Section 16370 and Section 16375.

#### 3.1.3 Painting

The heat affected zone of field welded galvanized surfaces and other galvanized surfaces damaged during installation shall be cleaned in compliance with SSPC SP 10 and painted in accordance with Section 09900. Steel and iron appurtenances, piping, and supports shall be cleaned in compliance with SSPC SP 10 and painted with SSPC Paint 16, coal-tar epoxy-polyamide.

### 3.2 PIPING

#### 3.2.1 General

All piping in valve manholes shall be steel and insulated. Insulation shall be protected with an aluminum jacket. Pipe shall be accurately cut to measurements established at the site and shall be worked into place without springing or forcing. Pipe and insulation shall clear all openings and equipment. Excessive cutting or other weakening of structural members to facilitate piping installation will not be permitted. Burrs shall be removed from ends of pipe by reaming. Installation shall permit free expansion and contraction without damage to joints or hangers. Piping shall be installed in accordance with ASME B31.1. Joints for piping in valve manholes shall be welded, except joints at traps, strainers, and at valves and piping 20 mm and smaller which may be threaded. Flanged joints will be permitted for dielectric isolation only. Supports, anchors, or stays shall not be attached where either expansion or the weight of the pipe will cause damage to permanent construction. The method of attaching supports shall not interfere with the operation of the cathodic protection system.

#### 3.2.2 Welded Joints

Joints between sections of pipe, between sections of pipe and valves, and between sections of pipe and fittings shall be welded except where joints

are allowed to be screwed for pipe sizes 20 mm and smaller. The welding shall conform to the requirements specified in paragraph WELDING.

### 3.2.3 Flanged and Threaded Joints

#### 3.2.3.1 Flanged Joints

Flanged joints shall be faced true, provided with gaskets, and made perfectly square and tight. Flanged joints will be used only for electrical isolation and in other special cases where connected equipment is available with only flanged joints, or, when specifically shown on the drawings. Electrically isolated flange joints shall be provided at all connections to or from the heat distribution system and between dissimilar metals.

#### 3.2.3.2 Threaded Joints

Threaded joints shall have graphite or inert filler and oil, graphite compound, or polytetrafluoroethylene tape applied to the male threads only. Unions shall be provided at all screwed valves, strainers and connections to equipment 20 mm and smaller. Dielectric unions shall be used at connections of dissimilar metals in 20 mm inch and smaller piping. When used on High Temperature Water Systems, threaded joints shall be seal welded.

#### 3.2.4 Reducing Fittings

Eccentric reducers in horizontal runs shall be installed with the straight side down. Changes in horizontal piping sizes shall be made through eccentric reducing fittings.

#### 3.2.5 Branch Connections

Branches from mains shall branch off top of mains as indicated or as approved. Connections shall insure unrestricted circulation, elimination of air pockets, and shall permit the complete drainage of the system. Branch connections may be made with either welding tees or forged branch outlet fittings. Branch outlet fittings where used shall be forged and shall be no larger than two nominal pipe sizes smaller than the main run. Branch outlet fittings shall be reinforced to withstand external strains and designed to withstand full pipe bursting strength.

#### 3.2.6 Pipe Supports in Valve Manholes

Horizontal and vertical runs of pipe in valve manholes shall be securely supported.

### 3.3 WELDING

Piping shall be welded in accordance with qualified procedures using performance qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPV IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified 24 hours in advance of tests and the tests shall be performed at the work site. The welder or welding operator shall apply his assigned symbol near each weld he makes as a permanent record. Structural members shall be welded in accordance with Section 05120.



### 3.4 INSULATION

#### 3.4.1 General

The insulation shall be installed so that it will not be damaged by pipe expansion or contraction. Insulation shall not become wet before, during or after installation. Insulation installed over welds shall be grooved to assure a snug fit. Insulation shall be held in place with stainless steel straps. A minimum of 2 bands shall be installed on each individual length of insulation and maximum spacing shall not exceed 450 mm centers.

#### 3.4.2 Installation

Material shall be installed in accordance with published installation instructions of the manufacturer. Insulation materials shall not be applied until piping tests are completed. Prior to application, surfaces shall be thoroughly cleaned of moisture, grease, dirt, rust, and scale and painted where required.

#### 3.4.3 Insulation on Pipes Passing Through Sleeves

Insulation shall be continuous as required by paragraph Pipe Sleeves Through Valve Manhole Cover. Aluminum jackets shall be provided over the insulation. When penetrating valve manhole walls, aluminum jacket shall extend not less than 50 mm beyond the sleeve on each side of the wall and shall be secured with an aluminum band on each side of the wall. Where flashing is provided, the jacket shall be secured with not less than one band located not more than 25 mm from the end of the jacket. When penetrating valve manhole tops, pipe shall be insulated as required for valve manhole service as indicated.

#### 3.4.4 Covering of Insulation in Valve Manholes

The insulation for pipe, flanges, valves, and fittings shall be covered with aluminum jackets.

#### 3.4.5 Insulation of Piping Accessories in Valve Manholes

Flanges, couplings, unions, valves, fittings, and other pipe accessories, unless otherwise shown or approved, shall be insulated with removable and reusable factory premolded, prefabricated or field fabricated insulation. For accessories in valve manholes, aluminum sheet shall be applied over the insulation. Where accessories are designated not to be insulated, the adjoining insulation and jacket shall terminate neatly. The terminations for the chilled water systems shall provide a complete vapor seal.

#### 3.4.6 Insulation Sealing for Chilled Water Systems

The ends of insulation shall be sealed with vapor barrier. Penetrations shall be caulked. Caulking shall be applied to parting line between equipment and removable section insulation. Upon completion of installation of the insulation, including removable sections, two coats of vapor barrier coating shall be applied with a layer of glass cloth embedded between the coats. The total dry thickness of the finish shall be 1.6 mm. The coating shall be applied so that the removable sections are coated separate from the body of the equipment so these sections remain removable. Coating shall be applied to flanges, unions, valves, anchors, fittings and accessories, all

terminations and all insulation not protected by factory vapor barrier jackets or PVC fitting covers. Tape seams shall overlap 25 mm. The coating shall extend out onto the adjoining pipe insulation 50 mm. Insulation terminations shall be tapered to unions at a 45-degree angle.

### 3.4.7 Insulation Thickness

The minimum thickness of insulation for each section of pipe shall be in accordance with Table 1.

TABLE 1  
Minimum Pipe Insulation Thickness (In millimeters)

For steam (110 kPa to 1724 kPa) and High Temperature  
Hot Water Supply and Return (121 degrees C to 232 degrees C)

Nominal Pipe Diameter (mm)	Paroc	Epitherm Delta	Kaylo-10 Thermo-12 Super Caltemp	Foamglas
25	50	63	100	110
40	50	63	100	110
50	63	85	110	125
65	63	85	110	125
80	75	100	125	150
100	75	100	125	150
125	75	100	125	150
150	85	110	135	150
200	85	110	135	150
250	100	125	150	165
300	100	125	150	165
350	100	125	150	165
400	100	125	150	165
450	100	125	150	165

#### NOTES:

1. Delta mineral wool board insulation V-grooved by NOVA Group.

### 3.5 VALVE MANHOLES AND ACCESSORIES

#### 3.5.1 Piping and Equipment in Valve Manholes

Piping and equipment in valve manholes shall be installed so as to provide easy access without stepping on piping or equipment, and to provide sufficient working room. Piping and equipment in valve manholes shall be installed and supported as shown on the drawings. All globe, angle and gate valves shall be installed with the stems horizontal or above.

### 3.6 TESTS

Tests of piping in the valve manholes will be performed as part of the testing of the direct buried conduit system. These tests shall include the piping in the valve manhole and shall be in accordance with the system supplier's Approved Brochure or the contract specifications.

## SECTION 02711

## FOUNDATION DRAINAGE SYSTEM

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 2751	(1993) Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings
ASTM D 3034	(1994) Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D 3212	(1992) Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM F 405	(1993) Corrugated Polyethylene (PE) Tubing and Fittings
ASTM F 667	(1985) Large Diameter Corrugated Polyethylene Tubing and Fittings
ASTM F 758	(1993) Smooth-Wall Poly(Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage
ASTM F 949	(1993) Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe With a Smooth Interior and Fittings

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300.

## SD-13 Certificates

Materials; FIO.

Certifications from the manufacturers attesting that materials meet specification requirements.

## SD-14 Samples

Materials; FIO.

Two randomly selected samples of each type of pipe and fitting, prior to delivery of materials to the site.

### 1.3 DELIVERY, STORAGE AND HANDLING

Materials placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Plastic pipe shall not be exposed to direct sunlight for more than 6 months from time of manufacturer to installation.

## 2 PRODUCTS

### 2.1 MATERIALS

Pipe for foundation drainage system shall be of the type and size indicated. Appropriate transitions, adapters, or joint details must be used where pipes of different types or materials are connected.

#### 2.1.1 Plastic Pipe

Plastic pipe shall contain ultraviolet inhibitor to provide protection from exposure to direct sunlight.

##### 2.1.1.1 Corrugated Polyethylene (PE) Drainage Pipe

ASTM F 405 heavy duty for pipe. Fittings shall be pipe manufacturer's standard type and shall conform to the indicated specification.

##### 2.1.1.2 Acrylonitrile-Butadiene-Styrene (ABS) Pipe

ASTM D 2751, with a maximum SDR of 26.

##### 2.1.1.3 Polyvinyl Chloride (PVC) Pipe

ASTM F 758, Type PS 46, ASTM D 3034, or ASTM F 949 with a minimum pipe stiffness of 317 MPa.

##### 2.1.1.4 Circular Perforations in Plastic Pipe

Circular holes shall be cleanly cut, not more than 8 mm or less than 5 mm in diameter, and arranged in rows parallel to the longitudinal axis of the pipe. Perforations shall be approximately 75 mm apart, center-to-center, along rows. The rows shall be approximately 38 mm apart and arranged in a staggered pattern so that all perforations lie at the midpoint between perforations in adjacent rows. The rows shall be spaced over not more than 155 degrees of circumference. The spigot or tongue end of the pipe shall not be perforated for a length equal to the depth of the socket and perforations shall continue at uniform spacing over the entire length of the pipe. Manufacturer's standard perforated pipe which essentially meets these requirements may be used with prior approval of the Contracting Officer.

##### 2.1.1.5 Slotted Perforations in Plastic Pipe

Circumferential slots shall be cleanly cut so as not to restrict the inflow of water and uniformly spaced along the length and circumference of the tubing. Width of slots shall not exceed 3 mm or be less than 0.8 mm. The length of individual slots shall not exceed 10 percent of the tubing inside nominal circumference. Rows of slots shall be symmetrically spaced so that they are fully contained in quadrants of the pipe. Slots shall be centered in the valleys of the corrugations of profile wall pipe. The water inlet

area shall be a minimum of 42 mm per linear meter of tubing. Manufacturer's standard perforated pipe which essentially meets these requirements may be used with prior approval of the Contracting Officer.

#### 2.1.2 Fittings

Fittings shall be of compatible materials for pipe, of corresponding weight and quality, and as specified herein.

### 2.2 PREFABRICATED DRAINAGE MAT SYSTEM

#### 2.2.1 General

The drainage mat system shall consist of a geocomposite drain sheet composed of a corrugated drain mat with filter fabric facing. The composite system shall be Greenstreak Sheet drain HS as manufactured by Greenstreak, Inc., St Louis, MO (1 800 325-9504) or Stripdrain 75 as manufactured by Contech Construction Products, Middletown, Ohio (Houston Sales Office, 713 973-9908) or approved equal.

#### 2.2.2 Corrugated Sheet

The corrugated core shall be a high density polyethylene (HDPE) or high impact polystyrene (HIPS) Core of a minimum 7.6 mm inches thick, and a minimum compressive strength of 393 MPa when tested in accordance with ASTM D 1621.

#### 2.2.3 Filter Fabric

Filter shall be factory adhered to the corrugated core. Fabric shall be a geotextile 0.027 kg/cu. m. min weight, min. grab strength of 356 N (ASTM D 4632) and Equivalent Opening Size (EOS) of 70 to 100 US Standard Sieve. (ASTM D 1752).

### 2.3 INSULATION BOARD

Insulation board shall be a rigid board-type insulation of extruded polystyrene, polyurethane, or polyisocyanurate. Polystyrene shall conform to ASTM C 578. Polyurethane or polyisocyanurate shall conform to FS HH-I-1972/1 Class 2, faced with aluminum foil on both sides of the foam. The insulation shall be a standard product and shall be marked with not less than the manufacturer's trademark or name, the specification number, the permeance and R-values.

## 3 EXECUTION

### 3.1 GENERAL REQUIREMENTS

Drainage lines shall be constructed of drain tile or perforated pipe as specified in Part 2 above. Foundation pipe shall be connected to the storm drainage system as shown. Outlet lines connecting drain pipe to storm drainage system shall be constructed of closed-joint nonperforated pipe. Applications of insulation to waterproofing system materials and drainage mat to insulation materials shall be as recommended by the manufacturer of the materials. Waterproofing is specified Section 07111 and Section 07112.

### 3.2 PIPE LAYING

Drain lines shall be laid to true grades and alignment with a continuous fall in the direction of flow. Bells of pipe sections shall face upgrade. Interior of pipe shall be cleaned thoroughly before being laid. When drain lines are left open for connection to discharge lines, the open ends shall be temporarily closed and the location marked with wooden stakes. Perforated pipe shall be laid with perforations facing down. Any length that has had its grade or joints disturbed shall be removed and relaid. Perforated corrugated polyethylene drainage tubing and plastic piping shall be installed in accordance with manufacturer's specifications and as specified herein.

#### 3.2.1 Jointing

##### 3.2.1.1 Perforated and Porous Pipes

Perforated drain pipes shall be laid with closed joints.

##### 3.2.1.2 ABS Pipe

ABS pipe shall be joined using solvent cement or elastomeric joints and shall be in accordance with ASTM D 2751, with dimensions and tolerances in accordance with TABLE II therein.

##### 3.2.1.3 PVC Pipe

PVC pipe joints shall be in accordance with ASTM D 3034, ASTM D 3212, or ASTM F 949.

##### 3.2.1.4 Corrugated Polyethylene

Corrugated polyethylene (PE) pipe joints shall be in accordance with ASTM F 405 or ASTM F 667.

### 3.3 PREFABRICATED DRAINAGE MAT

The drainage mat shall be installed at the location and the shown. Installation shall be in accordance with the manufacturers written instructions.

### 3.4 BACKFILL

After joints and connections have been inspected and approved, the specified pervious backfill material shall be placed full width between pipe and adjacent walls and 305 mm above the top of the pipe. When placing the backfill, care shall be taken to prevent displacement of or injury to the pipe or tile or drainage mat. Backfill shall be placed and compacted as specified in Section 02222.

## SECTION 02720

## STORM-DRAINAGE SYSTEM

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS  
(AASHTO)

AASHTO M 198 (1994) Joints for Circular Concrete Sewer and  
Culvert Pipe Using Flexible Watertight  
Gaskets

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 48 (1994a) Gray Iron Castings

ASTM A 536 (1984; R 1993) Ductile Iron Castings

ASTM B 26 (1996) Aluminum-Alloy Sand Castings

ASTM C 76 (1995) Reinforced Concrete Culvert, Storm  
Drain, and Sewer Pipe

ASTM C 231 (1991b) Air Content of Freshly Mixed Concrete  
by the Pressure Method

ASTM C 270 (1996a) Mortar for Unit Masonry

ASTM C 443 (1994) Joints for Circular Concrete Sewer and  
Culvert Pipe, Using Rubber Gaskets

ASTM C 478 (1994) Precast Reinforced Concrete Manhole  
Sections

ASTM D 1751 (1983; R 1991) Preformed Expansion Joint  
Filler for Concrete Paving and Structural  
Construction (Nonextruding and Resilient  
Bituminous Types)

ASTM D 1752 (1984; R 1992) Preformed Sponge Rubber and  
Cork Expansion Joint Fillers for Concrete  
Paving and Structural Construction

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300.

## SD-06 Instructions

Placing Pipe; FIO.

Printed copies of the manufacturer's recommendations for installation procedures of the material being placed, prior to installation.

## SD-13 Certificates

Pipe Tests; FIO. Frame and Cover for Gratings; FIO.

Certified copies of test reports demonstrating conformance to applicable pipe specifications, before pipe is installed. Certification on the ability of frame and cover or gratings to carry the imposed live load.

## 1.3 DELIVERY, STORAGE, AND HANDLING

## 1.3.1 Delivery and Storage

Materials delivered to site shall be inspected for damage, unloaded, and stored with a minimum of handling. Materials shall not be stored directly on the ground. The inside of pipes and fittings shall be kept free of dirt and debris. Gasket materials and plastic materials shall be protected from exposure to the direct sunlight over extended periods.

## 1.3.2 Handling

Materials shall be handled in such a manner as to ensure delivery to the trench in sound, undamaged condition. Pipe shall be carried to the trench, not dragged.

## 2 PRODUCTS

## 2.1 PIPE

Pipe for storm drains shall be reinforced concrete pipe of the sizes indicated and shall conform to ASTM C 76, class II or III.

## 2.2 MISCELLANEOUS MATERIALS

## 2.2.1 Concrete

Unless otherwise specified, concrete and reinforced concrete shall conform to the requirements for 20.68 MPa concrete under Section 03300. The concrete mixture shall have air content by volume of concrete, based on measurements made immediately after discharge from the mixer, of 5 to 7 percent when maximum size of coarse aggregate exceeds 37.5 mm. Air content shall be determined in accordance with ASTM C 231. The concrete covering over steel reinforcing shall not be less than 25 mm thick for covers and not less than 40 mm thick for walls and flooring. Concrete covering deposited directly against the ground shall have a thickness of at least 75 mm between steel and ground. Expansion-joint filler material shall conform to ASTM D 1751, or ASTM D 1752, or shall be resin-impregnated fiberboard conforming to the physical requirements of ASTM D 1752.



### 2.2.2 Mortar

Mortar for pipe connections to other drainage structures, and brick or block construction shall conform to ASTM C 270, Type M, except the maximum placement time shall be 1 hour. The quantity of water in the mixture shall be sufficient to produce a stiff workable mortar. Water shall be clean and free of harmful acids, alkalies, and organic impurities. The mortar shall be used within 30 minutes after the ingredients are mixed with water. The inside of the joint shall be wiped clean and finished smooth. The mortar head on the outside shall be protected from air and sun with a proper covering until satisfactorily cured.

### 2.2.3 Precast Reinforced Concrete Manholes

Precast reinforced concrete manholes shall conform to ASTM C 478.

### 2.2.4 Prefabricated Corrugated Metal Manholes

Manholes shall be of the type and design recommended by the manufacturer. Manholes shall be complete with frames and cover, or frames and gratings.

### 2.2.5 Frame and Cover for Gratings

Frame and cover for gratings shall be cast gray iron, ASTM A 48, Class 35B; cast ductile iron, ASTM A 536, Grade 65-45-12; or cast aluminum, ASTM B 26, Alloy 356.OT6. Weight, shape, size, and waterway openings for grates and curb inlets shall be as indicated on the plans.

### 2.2.6 Joints

#### 2.2.6.1 Flexible Gaskets

Flexible gasket joints shall be made with plastic or rubber-type gaskets. The design of joints and the physical requirements for plastic gaskets shall conform to AASHTO M 198, and rubber-type gaskets shall conform to ASTM C 443. Gaskets shall have not more than one factory-fabricated splice, except that two factory-fabricated splices of the rubber-type gasket are permitted if the nominal diameter of the pipe being gasketed exceeds 1.37 m.

### 2.2.7 Plastic Sealing Compound

Requirements for preformed plastic sealing compound shall conform to FS SS-S-210.

## 3 EXECUTION

### 3.1 EXCAVATION FOR PIPE AND DRAINAGE STRUCTURES

Excavation of trenches and for appurtenances and backfilling for culverts and storm drains shall be in accordance with the applicable portions of Section 02222.

### 3.2 PLACING PIPE

Each pipe shall be carefully examined before being laid, and defective or damaged pipe shall not be used. Pipelines shall be laid to the grades and alignment indicated. Proper facilities shall be provided for lowering

sections of pipe into trenches. Under no circumstances shall pipe be laid in water, and no pipe shall be laid when trench conditions or weather are unsuitable for such work. Diversion of drainage or dewatering of trenches during construction shall be provided as necessary. All pipe in place shall be inspected before backfilling, and those pipes damaged during placement shall be removed and replaced.

### 3.3 JOINTS

Joints for concrete pipe may be either plastic sealing compound or flexible gasket type.

### 3.4 PLASTIC SEALING COMPOUND JOINTS FOR TONGUE-AND-GROOVED PIPE

Jointing shall conform to the recommendation of the compound manufacturer. Surfaces to receive lubricants, primers, or adhesives shall be dry and clean. Sealing compounds shall be affixed to the pipe not more than 3 hours prior to installation of the pipe, and shall be protected from the sun, blowing dust, and other deleterious agents at all times. Sealing compounds shall be inspected before installation of the pipe, and any loose or improperly affixed sealing compound shall be removed and replaced. The pipe shall be aligned with the previously installed pipe, and the joint pulled together. If, while making the joint with mastic-type sealant, a slight protrusion of the material is not visible along the entire inner and outer circumference of the joint when the joint is pulled up, the pipe shall be removed and the joint remade. After the joint is made, all inner protrusions will be cut off flush with the inner surface of the pipe. If nonmastic-type sealant material is used, the "Squeeze-Out" requirement above shall be waived.

### 3.5 FLEXIBLE GASKET JOINTS

Jointing shall be as recommended by the pipe manufacturer with regard to use of lubricants, cements, adhesives, and other special installation requirements. Surfaces to receive lubricants, cements, or adhesives shall be clean and dry. Gaskets and jointing materials shall be affixed to the pipe not more than 24 hours prior to the installation of the pipe, and shall be protected from the sun, blowing dust, and other deleterious agents at all times. Gaskets and jointing materials shall be inspected before installing the pipe; any loose or improperly affixed gaskets and jointing materials shall be removed and replaced. The pipe shall be aligned with the previously installed pipe, and the joint pushed home. If, while the joint is being made the gasket becomes visibly dislocated the pipe shall be removed and the joint remade.

### 3.6 DRAINAGE STRUCTURES

Construction of manholes and inlets shall be of reinforced concrete, plain concrete, or precast reinforced concrete, complete with frames and covers or gratings. Joints between precast concrete risers and tops shall be full-bedded in cement mortar and shall be smoothed to a uniform surface on both interior and exterior of the structure or shall be made with flexible rubber-type gaskets as specified in paragraph JOINTS above.

## SECTION 02730

## SANITARY SEWERS

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 74	(1994) Cast Iron Soil Pipe and Fittings
ASTM A 123	(1989a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM C 150	(1995) Portland Cement
ASTM C 270	(1995a) Mortar for Unit Masonry
ASTM C 478	(1994) Precast Reinforced Concrete Manhole Sections
ASTM C 478M	(1994) Precast Reinforced Concrete Manhole Sections (Metric)
ASTM C 564	(1995) Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C 700	(1995) Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
ASTM C 828	(1990) Low-Pressure Air Test of Vitrified Clay Pipe Lines
ASTM C 924	(1989) Concrete Pipe Sewer Lines by Low-Pressure Air Test Method
ASTM C 972	(1982; R 1990) Test Method for Compression-Recovery of Tape Sealant
ASTM D 412	(1992) Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension
ASTM D 624	(1991) Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
ASTM D 1784	(1992) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 3034	(1994) Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings

ASTM D 3212	(1992) Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM F 402	(1993) Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings
ASTM F 794	(1995a) Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter
ASTM F 949	(1993a) Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings

## AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C105	(1988) Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids
AWWA C110	(1993) Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (75 mm through 1200 mm), for Water and Other Liquids
AWWA C111	(1990) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115	(1988) Flanged Ductile-Iron Pipe with Threaded Flanges
AWWA C151	(1991) Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 49	(1994) Hazardous Chemicals Data
NFPA 325M	(1991) Fire Hazard Properties of Flammable Liquids, Gases, and Volatile Solids
NFPA 704	(1990) Identification of the Fire Hazards of Materials

## UNI-BELL PVC PIPE ASSOCIATION (UBPPA)

UBPPA UNI-B-6	(1990) Recommended Practice for the Low-Pressure Air Testing of Installed Sewer Pipe
UBPPA UNI-B-9	(1990; Addenda 1994) Recommended Performance Specification for Polyvinyl Chloride (PVC) Profile Wall Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter (Nominal Pipe Sizes 4-48 inch)

## 1.2 GENERAL REQUIREMENTS

The construction required herein shall include appurtenant structures and building sewers to points of connection with the building drains 1.5 m outside the building to which the sewer system is to be connected. The Contractor shall replace damaged material and redo unacceptable work at no additional cost to the Government. Excavation and backfilling is specified in Section 02222. Backfilling shall be accomplished after inspection by the Contracting Officer. Before, during, and after installation, plastic pipe and fittings shall be protected from any environment that would result in damage or deterioration to the material. The Contractor shall have a copy of the manufacturer's instructions available at the construction site at all times and shall follow these instructions unless directed otherwise by the Contracting Officer. Solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install the plastic pipe shall be stored in accordance with the manufacturer's recommendation and shall be discarded if the storage period exceeds the recommended shelf life. Solvents in use shall be discarded when the recommended pot life is exceeded.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300.

## 2 PRODUCTS

### 2.1 PIPE

Pipe shall conform to the respective specifications and other requirements specified below.

#### 2.1.1 Plastic Pipe

Polyvinyl chloride (PVC) composite sewer piping shall conform to ASTM D 2680. Size 200 mm through 380 mm. diameter.

##### 2.1.1.1 PVC Pipe

ASTM D 3034, Type PSM with a maximum SDR of 35, Size 380 mm or less in diameter. ASTM F 949 for corrugated sewer pipes with a smooth interior. UBPPA UNI-B-9 and ASTM F 794, Series 46, for ribbed sewer pipe with smooth interior, size 200 mm through 1200 mm diameters. PVC shall be certified by the compounder as meeting the requirements of ASTM D 1784, cell Class 12454B. The pipe stiffness shall be greater than or equal to 735/D for cohesionless material pipe trench backfills.

#### 2.1.2 Ductile Iron Pipe

Pipe shall conform to AWWA C151 unless otherwise shown or specified.

#### 2.1.3 Cast Iron Soil Pipe

ASTM A 74, Class SV except Class XH where indicated. When installed underground, pipe shall be encased with polyethylene in accordance with AWWA C105.

#### 2.1.4 Clay Pipe

ASTM C 700

### 2.2 FITTINGS

Fittings shall be compatible with the pipe supplied and shall have a strength not less than that of the pipe. Fittings shall conform to the respective specifications and other requirements specified below.

#### 2.2.1 Plastic Pipe

PVC composite sewer pipe fittings shall conform to ASTM D 2680.

##### 2.2.1.1 PVC Pipe

ASTM D 3034 for type PSM pipe. ASTM F 949 for corrugated sewer pipe with a smooth interior. UBPPA UNI-B-9 and ASTM F 794, Series 46, for ribbed sewer pipe with smooth interior.

#### 2.2.2 Ductile Iron Pipe

Mechanical fittings shall conform to AWWA C110, rated for 1.03 MPa. Push-on fittings shall conform to AWWA C110 and AWWA C111, rated for 10.3 MPa.

#### 2.2.3 Cast Iron Soil Pipe

ASTM A 74.

#### 2.2.4 Clay Pipe

ASTM C 700.

### 2.3 JOINTS

Joints installation shall comply with the manufacturer's instructions.

#### 2.3.1 Plastic Pipe

Flexible plastic pipe (PVC or high density polyethylene pipe) gasketed joints shall conform to ASTM D 3212.

#### 2.3.2 Ductile Iron Pipe

Push-on joints shall conform to AWWA C111. Mechanical joints shall conform to AWWA C111 as modified by AWWA C151. Flanged joints shall conform to AWWA C115.

#### 2.3.3 Cast Iron Soil Pipe

Rubber gaskets for compression joints shall conform to ASTM C 564. Packing material for caulked joints shall be twisted jute or oakum, tarred type, or asphalt-saturated cellulose-fiber. Joints for acid resisting cast iron soil pipe shall be made with acid resistant non-asbestos packing. The packing shall contain no material which would affect adhesion of the joint sealing material to the pipe. Lead shall be suitable for caulking of joints.

#### 2.3.4 Clay Pipe

Compression joints shall conform to ASTM C 425.

#### 2.4 BRANCH CONNECTIONS

Branch connections shall be made by use of regular fittings or solvent cemented saddles as approved. Saddles for PVC composite pipe shall conform to Figure 2 of ASTM D 2680; and saddles for PVC pipe shall conform to Table 4 of ASTM D 3034.

#### 2.5 FRAMES AND COVERS

Frames and covers shall be cast iron, ductile iron or reinforced concrete. Cast iron frames and covers shall be as indicated or shall be of type as suitable for the application, circular, without vent holes. The frames and covers shall have a combined weight of not less than 181.4 kg. Reinforced concrete frames and covers shall be as indicated or shall conform to ASTM C 478 or ASTM C 478M. The word "Sewer" shall be stamped or cast into covers so that it is plainly visible.

#### 2.6 STEEL LADDER

A steel ladder shall be provided where the depth of a manhole exceeds 3.6 m. The ladder shall not be less than 406.4 mm in width, with 19.1 mm diameter rungs spaced 304.8 mm apart. The two stringers shall be a minimum 9.5 mm thick and 50.8 mm wide. Ladders and inserts shall be galvanized after fabrication in conformance with ASTM A 123.

#### 2.7 CEMENT MORTAR

Cement mortar shall conform to ASTM C 270, Type M with Type II cement.

##### 2.7.1 Portland Cement

Portland cement shall conform to ASTM C 150, Type II for concrete used in manholes and type optional with the Contractor for cement used in concrete cradle, concrete encasement, and thrust blocking.

#### 2.8 STRUCTURES

##### 2.8.1 Precast Reinforced Concrete Manhole Sections

Precast reinforced concrete manhole sections shall conform to ASTM C 478, except that portland cement shall be as specified herein. Joints shall be cement mortar, an approved mastic, rubber gaskets, a combination of these types; or the use of external preformed rubber joint seals and extruded rolls of rubber with mastic adhesive on one side.

### 3 EXECUTION

#### 3.1 INSTALLATION

##### 3.1.1 Adjacent Facilities

###### 3.1.1.1 Water Lines

Where the location of the sewer is not clearly defined by dimensions on the drawings, the sewer shall not be closer horizontally than 3 m to a water-supply main or service line, except that where the bottom of the water pipe will be at least 300 mm above the top of the sewer pipe, the horizontal spacing may be a minimum of 2 m. Where gravity-flow sewers cross above water lines, the sewer pipe for a distance of 3 m on each side of the crossing shall be fully encased in concrete or shall be acceptable pressure pipe with no joint closer horizontally than 1 m to the crossing. The thickness of the concrete encasement including that at the pipe joints shall be not less than 100 mm.

##### 3.1.2 Pipe Laying

- a. Pipe shall be protected during handling against impact shocks and free fall and the pipe interior shall be free of extraneous material.
- b. Pipe laying shall proceed upgrade with the spigot ends of bell-and-spigot pipe and tongue ends of tongue-and-groove pipe pointing in the direction of the flow. Each pipe shall be laid accurately to the line and grade shown on the drawings. Pipe shall be laid and centered so that the sewer has a uniform invert. As the work progresses, the interior of the sewer shall be cleared of all superfluous materials.
- c. Before making pipe joints all surfaces of the portions of the pipe to be joined shall be clean and dry. Lubricants, primers, and adhesives shall be used as recommended by the pipe manufacturer. The joints shall then be placed, fitted, joined, and adjusted to obtain the degree of water tightness required.
- d. Installations of solvent weld joint pipe, using PVC pipe and fittings shall be in accordance with ASTM F 402. All required precautions shall be taken to assure adequate trench ventilation and protection for workers installing the pipe.

###### 3.1.2.1 Caulked Joints

The packing material shall be well packed into the annular space to prevent the entrance of lead into the pipe. The remainder of the space shall be filled with molten lead that is hot enough to show a rapid change in color when stirred. Scum shall be removed before pouring. The lead shall be caulked to form a tight joint without overstraining the bell and shall have a minimum depth of 25 mm after caulking.



### 3.1.2.2 Trenches

Trenches shall be kept free of water and as dry as possible during bedding, laying, and jointing and for as long a period as required. When work is not in progress, open ends of pipe and fittings shall be satisfactorily closed so that no trench water or other material will enter the pipe or fittings.

### 3.1.2.3 Backfill

As soon as possible after the joint is made, sufficient backfill material shall be placed along the pipe to prevent pipe movement off line or grade. Plastic pipe shall be completely covered to prevent damage from ultraviolet light.

### 3.1.2.4 Width of Trench

If the maximum width of the trench at the top of the pipe, as specified in Section 02222 is exceeded for any reason other than by direction, the Contractor shall install at no additional cost to the Government such concrete cradling, pipe encasement, or other bedding required to support the added load of the backfill.

### 3.1.2.5 Joints

Joints between different pipe materials shall be made as specified, using approved jointing materials.

### 3.1.2.6 Handling and Storage

Pipe, fittings and joint material shall be handled and stored in accordance with the manufacturer's recommendations. Storage facilities for plastic pipe, fittings, joint materials and solvents shall be classified and marked in accordance with NFPA 704, with classification as indicated in NFPA 49 and NFPA 325M.

### 3.1.3 Leakage Tests

Lines shall be tested for leakage by low pressure air testing, infiltration tests or exfiltration tests, as appropriate. Low pressure air testing for vitrified clay pipes shall be as prescribed in ASTM C 828. Low pressure air testing for concrete pipes shall be as prescribed in ASTM C 828. Low pressure air testing for PVC pipe shall be as prescribed in UBPPA UNI-B-6. Low pressure air testing procedures for other pipe materials shall use the pressures and testing times prescribed in ASTM C 828 and ASTM C 924, after consultation with the pipe manufacturer. Prior to infiltration or exfiltration tests the trench shall be backfilled up to at least the lower half of the pipe. If required, sufficient additional backfill shall be placed to prevent pipe movement during testing, leaving the joints uncovered to permit inspection. Visible leaks encountered shall be corrected regardless of leakage test results. When the water table is 600 mm or more above the top of the pipe at the upper end of the pipeline section to be tested, infiltration shall be measured using a suitable weir or other device acceptable to the Contracting Officer. When the Contracting Officer determines that infiltration cannot be properly tested, an exfiltration test shall be made by filling the line to be tested with water so that a head of at least 600 mm is provided above both the water table and the top of the pipe at the upper end of the pipeline to be tested. The filled line shall

be allowed to stand until the pipe has reached its maximum absorption, but not less than 4 hours. After absorption, the head shall be re-established. The amount of water required to maintain this water level during a 2-hour test period shall be measured. Leakage as measured by either the infiltration test or exfiltration test shall not exceed 50 mL per 5 mm diameter per 100 meters of pipeline per hour. When leakage exceeds the maximum amount specified, satisfactory correction shall be made and retesting accomplished. Testing, correction, and retesting shall be made at no additional cost to the Government.

### 3.2 WYE BRANCHES

Wye branches shall be installed where sewer connections are indicated or where directed. Cutting into piping for connections shall not be done except in special approved cases. When the connecting pipe cannot be adequately supported on undisturbed earth or tamped backfill, the pipe shall be encased in concrete backfill or supported on a concrete cradle as directed. Concrete required because of conditions resulting from faulty construction methods or negligence by the Contractor shall be installed at no additional cost to the Government. The installation of wye branches in an existing sewer shall be made by a method which does not damage the integrity of the existing sewer. One acceptable method consists of removing one pipe section, breaking off the upper half of the bell of the next lower section and half of the running bell of wye section. After placing the new section, it shall be rotated so that the broken half of the bell will be at the bottom. The two joints shall then be made with joint packing and cement mortar.

### 3.3 MANHOLES

#### 3.3.1 General

Manholes shall be constructed of prefabricated plastic, concrete, or precast concrete manhole sections. The invert channels shall be smooth and semicircular in shape conforming to the inside of the adjacent sewer section. Changes in direction of flow shall be made with a smooth curve of as large a radius as the size of the manhole will permit. Changes in size and grade of the channels shall be made gradually and evenly. The invert channels shall be formed directly in the concrete of the manhole base, or shall be built up with brick and mortar, or shall be half tile laid in concrete, or shall be constructed by laying full section sewer pipe through the manhole and breaking out the top half after the surrounding concrete has hardened. Pipe connections shall be made to manhole using water stops, standard O-ring joints, special manhole coupling, or shall be made in accordance with the manufacturer's recommendation. The Contractor's proposed method of connection, list of materials selected, and specials required, shall be approved prior to installation. The floor of the manhole outside the channels shall be smooth and shall slope toward the channels not less than 100 mm per meter nor more than 200 mm per meter. Free drop inside the manholes shall not exceed 500 mm, measured from the invert of the inlet pipe to the top of the floor of the manhole outside the channels, and drop manholes shall be constructed whenever the free drop would otherwise be greater than 500 mm.

### 3.3.2 Steel Ladder

Ladder shall be adequately anchored to the wall by means of steel inserts spaced not more than 1850 mm apart vertically, and shall be installed to provide at least 150 mm of space between the wall and the rungs. The wall along the line of the ladder shall be vertical for its entire length.

### 3.3.3 Jointing, Plastering and Sealing

Mortar joints shall be completely filled and shall be smooth and free from surplus mortar on the inside of the manhole. Mortar and mastic joints between precast rings shall be full-bedded in jointing compound and shall be smoothed to a uniform surface on both the interior and exterior of the manhole. Installation of rubber gasket joints between precast rings shall be in accordance with the recommendations of the manufacturer. Precast rings may also be sealed by the use of extruded rolls of rubber with mastic adhesive on one side.

### 3.3.4 Frames and Covers

Unless otherwise indicated, tops of frames and covers shall be set flush with finished grade in paved areas or 50 mm higher than finished grade in unpaved areas. Frame and cover assemblies shall be sealed to manhole sections using external preformed rubber joint seals that meet the requirements of ASTM D 412 and ASTM D 624, or other methods specified in paragraph Jointing, Plastering and Sealing, unless otherwise specified.

### 3.3.5 External Preformed Rubber Joint Seals

External preformed rubber joint seals and extruded rolls of rubber with mastic adhesive shall meet the requirements of ASTM D 412 and ASTM C 972 to ensure conformance with paragraph Leakage Tests. The seal shall be multi-section with neoprene rubber top section and all lower sections made of Ethylene Propylene Di Monomer (EPDM) rubber with a minimum thickness of 1.5 mm. Each unit shall consist of a top and a bottom section and shall have mastic on the bottom of the bottom section and mastic on the top and bottom of the top section. The mastic shall be non-hardening butyl rubber sealant and shall seal to the cone/top slab of the manhole/catch basin and over the lip of the casting. One unit shall seal a casting and up to six, 50 mm adjusting rings. The bottom section will be 305 mm in height. A 152 mm high top section will cover up to two, 50 mm adjusting rings. A 305 mm high bottom section will cover up to six, 50 mm adjusting rings. Extension sections shall cover up to two more adjusting rings. Each extension shall overlap the bottom section by 50 mm and shall be overlapped by the top section by 50 mm.

## 3.4 CONNECTIONS TO EXISTING MANHOLES

Pipe connections to existing manholes shall be made in such manner that the finish work will conform as nearly as practicable to the essential applicable requirements specified for new manholes, including all necessary concrete work, cutting, and shaping. The connection shall be centered on the manhole. Holes for the new pipe shall be of sufficient diameter to allow packing cement mortar around the entire periphery of the pipe but no larger than 1-1/2 times the diameter of the pipe. Cutting the manhole shall be done in a manner that will cause the least damage to the walls.

### 3.5 BUILDING CONNECTIONS

Building connections shall include the lines to and connection with the building waste drainage piping at a point approximately 1.5 m outside the building, unless otherwise indicated. Where building drain piping is not installed, the Contractor shall terminate the building connections approximately 1.5 m from the site of the building at a point and in a manner designated.

### 3.6 CLEANOUTS AND OTHER APPURTENANCES

Cleanouts and other appurtenances shall be installed where shown on the drawings or as directed by the Contracting Officer, and shall conform to the detail of the drawings.

## SECTION 02811

## LAWN SPRINKLER SYSTEM

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 88	(1996) Seamless Copper Water Tube
ASTM D 1785	(1994) Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2241	(1994) Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2464	(1994) Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2466	(1994a) Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D 2468	(1993) Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe Fittings, Schedule 40
ASTM D 3261	(1993) Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing

## AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1012	(1972; Rev thru Sep 1993) Backflow Preventers with Intermediate Atmospheric Vent
ASSE 1013	(1971; Rev thru Oct 1993) Reduced Pressure Principle Backflow Preventers
ASSE 1020	(1974; Rev Feb 1989) Pressure Vacuum Breaker Assembly (Recommended for Outdoor Usage)

## AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C901	(1988; Errata 1988) Polyethylene (PE) Pressure Pipe and Tubing, 1/2 In. Through 3 In., for Water Service
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## FOUNDATION FOR CROSS-CONNECTION CONTROL AND HYDRAULIC RESEARCH (FCCHR)

FCCHR-01	(1988) Manual of Cross-Connection Control
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MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS  
INDUSTRY (MSS)

MSS SP-80 (1987) Bronze Gate, Globe, Angle and Check  
Valves

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2 (1993) Industrial Control Devices,  
Controllers and Assemblies

NEMA ICS 6 (1993) Enclosures for Industrial Control and  
Systems

## 1.2 DEFINITIONS

Diameter of Coverage - diameter of the surface area receiving water  
(pertains to full or part circle).  
Head:

Bubbler - special head with adjustable flows for deep watering.

Fill-in - heads not located on the basic symmetrical pattern and/or which  
may not have the same coverage as the heads in the pattern.

Pop-up - spray or rotary head installed flush with the turf, containing a  
nozzle which rises above the turf when operating.

Rotary - head containing a nozzle that rotates, discharging a high velocity  
water stream.

Shrub - spray head designed for installation in or above shrubbery and  
flowers usually with a small diameter of coverage.

Spray - head containing a nozzle that discharges a fine uniform water spray.

Strip - spray head designed for watering long, narrow strips of turf or  
landscaping, usually in a square or rectangular pattern.

Header - water line leading off from a zone valve; subject to pressure only  
when zone is operating.

Lateral - water line leading off from a header to a head.

Main - water line under constant pressure, supplying the sprinkler zones.

Valve:

Throttle - valve used to regulate flow to a zone.

Zone - valve used to activate/terminate flow to a zone.

Zone - a section of heads controlled by one valve.

### 1.3 DESIGN CRITERIA

#### 1.3.1 General

- a. Contractor shall design the system in accordance with industry accepted practice, recommendations of the manufacturer of the equipment provided, and the following requirements. Requirements herein shall prevail.
- b. The limits of the area to be covered shall be as indicated.
- c. Design pressure shall be based on available static pressure at the point of connection to the water system. Verify available static pressure with user agency at installation.
- d. System shall be automatic with controller(s) and remote controlled valves.
- e. A backflow preventer shall be installed on the sprinkler main between the tie-in to the potable water supply and the first valve off the main.
- f. A gate valve shall be installed upstream of the backflow preventer.
- g. Fixed pipe risers above grade shall be copper tubing.
- h. The sprinkler system shall be designed utilizing pipe sizes, valves, heads, and zone operation time schedules, to assure an economical and operational system with complete and even coverage. Lawn area systems shall be primarily of the spray head type except that pop-up rotary heads may be used in large open turf areas. Rotor heads shall not be used in areas less than 10.7 wide.
- i. Application rates for spray head zones shall be within 19 mm and 38 mm per hour and not less than 6 mm per hour for rotary head zones.
- j. Mains shall be manually drainable.
- k. Zones shall be drained automatically.

#### 1.3.2 Head Layout

##### 1.3.2.1 Turfed Areas:

- a. Triangular spacing of heads having the same diameter of coverage shall be used as the basic pattern.
- b. Maximum spacing between spray heads shall be 60% of the diameter of the listed spray coverage for spray heads, or shall be head to head coverage for rotary heads, or shall be the manufacturer's recommended spacing for a 11 km per hour wind, whichever is less.
- c. Equal spacing shall be used between heads of the same diameter of coverage on rows and between rows of heads.
- d. Part-circle heads, compatible with the basic pattern heads, shall be used at borders between turf areas and buildings, streets, walks, etc. Wasted coverage onto these areas shall be minimized except that spray onto

buildings will not be allowed. Sidewalks less than 1.52 m wide with turf on both sides need not be bordered with part-circle sprinkler heads.

e. Fill-in heads shall be used in areas where the basic pattern cannot be maintained or where the pattern is obstructed by trees, shrubs, poles, etc. Future size of plants shall be considered in placing fill-in heads in the latter case. Minimum overlap between fill-in heads and basic pattern heads shall be the overlap between basic pattern heads.

#### 1.3.2.2 Landscaped Areas

a. Spacing of heads shall be as outlined under Turfed Areas. Plants over 600 mm in height shall receive water from at least two sides.

b. Spray shall be above landscaped plantings from pop-up or fixed riser-mounted shrub heads except where plants will exceed 600 mm in height. Future size of plants shall be used for determining height of risers or pop-ups which shall not exceed 600 mm.

c. Bubblers shall be provided in landscaped areas where semi-flood watering is required. Throttle valves shall be used to control amount of flooding.

#### 1.3.3 Pipe Sizing

Flow velocities shall not exceed 2.7 m/sec for spray head zones and 1.5 m/sec for rotary zones. Pressure losses due to meters, valves, backflow preventer, pipe, pipe fittings, elevational differences, etc., shall be used in sizing lines. Pressure available at each head shall be within the minimum and maximum specified by the manufacturer. Total pressure drop between any heads of a spray head zone shall not exceed 30%. Differential pressure between any heads of a rotary zone shall not exceed 69 kPa .

#### 1.3.4 Zoning

Spray and rotary type heads shall not be installed in the same zone. Heads within the same zone shall have matched precipitation rate. Number of zones established shall minimize system operation time within economic reason as to size of pipe and number of operating valves required. A schedule of recommended zone operation times and sequence of operations of the installed system shall be provided upon completion of the work. Separate zones shall be provided for landscaped areas where watering requirements are different from the turfed areas.

#### 1.3.5 Electrical

Each controller shall be connected to a separate, unswitched circuit with its own circuit breaker. Wire size for power supply shall be governed by local codes. Wiring of controllers and valves shall comply with the manufacturer's instructions.

#### 1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300.



Design Analysis and Calculations; FIO. Spare Parts; FIO.

Design analyses and pressure calculations verifying that system will provide the irrigation requirements. Calculations shall include pressure losses to and residual pressure for each head in each zone, the difference in pressure between heads, and any other calculations necessary to conformance with manufacturers recommendations and these specifications.

Spare parts data for each different item of material and equipment specified, after approval of the related submittals and not later than the start of the field tests. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

#### SD-04 Drawings

Sprinkler System; GA.

Detail drawings for valves, sprinkler heads, backflow preventers, automatic controllers, emitter heads, and water hammer arresters. Drawing shall include of a complete list of equipment and materials, and manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts, and installation instructions. Drawings shall also contain complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will function as a unit. Drawings shall show proposed system layout, type and number of heads and emitters, zone valves, drain pockets, backflow devices, controllers, and mounting details of controllers. As-built Drawings which provide current factual information showing locations of mains, heads, valves, and controllers including deviations from and amendments to the drawings and changes in the work shall be included.

If any departures from the contract drawings are deemed necessary by the Contractor, details of such departures and reasons therefor shall be submitted in writing as soon as practicable after contract award to the authorized Government representative for written approval.

#### SD-06 Instructions

Sprinkler System; FIO.

Detailed procedures defining the Contractor's provisions for accident prevention, health protection, and other safety precautions for the work to be done.

#### SD-09 Reports

Field Tests; FIO.

Performance test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall indicate the final position of control valves.

## SD-13 Certificates

Sprinkler System; FIO.

The material supplier's or equipment manufacturer's statement that the supplied material or equipment meets specified requirements. Each certificate shall be signed by an official authorized to certify in behalf of material supplier or product manufacturer and shall identify quantity and date or dates of shipment or delivery to which the certificates apply.

## SD-19 Operation and Maintenance Manuals

Sprinkler System; FIO.

Six copies of operation and six copies of maintenance manuals for the equipment furnished. One complete set prior to field testing and the remainder upon acceptance. Operating manuals shall detail the step-by-step procedures required for system startup, operation, and shutdown. Operating manuals shall include the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features. Maintenance manuals shall list routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Maintenance manuals shall include piping and equipment layout, simplified wiring and control diagrams of the system as installed, and system programming schedule.

Manuals shall show a schedule of the measured or calculated flow rates for each zone, and a recommended controller setting and a schedule of times and duration of operation for each zone for each month or season based on a stated recommended precipitation requirement for the type of turf or plants and the geographical location of the installation.

## 1.5 CONTRACTOR QUALIFICATIONS

The Contractor's firm shall have been in the turf irrigation business for a continuous period of not less than 5 years prior to bid opening. Evidence shall be provided that the firm has designed and installed at least 3 sprinkler projects of similar scope as this project within the preceeding 12 months. In lieu of the above experience the Contractor may provide evidence of at least one of the following qualifications:

- a. Certified Irrigation Designer by The Irrigation Association, Arlington, VA.
- b. Registered Professional Engineer with at least 3 years experience in design and installation of turf irrigation.
- c. Approved designer of the American Society of Irrigation Consultants.
- d. Licensed by the Texas Turf Irrigation Organization, or licensed, certified, or registered by other state turf irrigation organizations, associations, or societies.

## 2 PRODUCTS

### 2.1 GENERAL

#### 2.1.1 Standard Products

Products furnished shall be standard products of manufacturers regularly engaged in the production of such products and shall be manufacturers' latest standard design that complies with the specification requirements. Products shall be specifically designed for the intended purpose.

#### 2.1.2 Delivery and Storage

Products delivered to site shall be inspected for damage, unloaded, and stored with the minimum of handling. Do not store products directly on the ground. Inside of pipes and fittings shall be kept free of dirt and debris.

#### 2.1.3 Handling

Products shall be handled in such a manner as to insure delivery to the trench in sound undamaged condition. Pipe shall be carried to the trench, not dragged. Gasket materials and plastic materials that are not to be installed immediately shall not be stored in the direct sunlight. Valves, controllers, sprinkler heads, etc., shall be removed from protective cover only upon installation.

### 2.2 PIPE AND FITTINGS

Pipe and fittings shall be plastic (PVC, ABS, or PE) or copper tubing. Pipe and fittings shall be rated for a minimum working pressure of 1032 kPa and a minimum hydrostatic pressure of 1380 kPa .

#### 2.2.1 Copper Tubing

ASTM B 88, type K, annealed. Fittings and specials shall be flared and shall conform to ANSI B16.26.

#### 2.2.2 PVC Plastic

Pipe shall conform to ASTM D 1785, Schedule 40, 80, or ASTM D 2241(SDR 21), class 12454-B, PVC 1120. Fittings for use with Schedule 80 pipe shall conform to the requirements of ASTM D 2464 or ASTM D 2467. Fittings and joints for SDR 21 pipe shall be elastomeric gasket push-on type. Fittings for schedule 40 pipe shall be solvent weld socket type conforming to ASTM D 2466.

#### 2.2.3 ABS

ABS pipe conforming to ASTM D 1527, Schedule 40 with ASTM D 2468 fittings

#### 2.2.4 Polyethylene (PE)

##### 2.2.4.1 Pipe

Pipe shall conform to AWWA C901, outside diameter base with dimension ratio (DR) of 9.3. Fittings shall conform to ASTM D 3261, DR of 9.3.

## 2.3 BACKFLOW PREVENTION DEVICE

Reduced pressure principle assemblies, double check valve assemblies, atmospheric (nonpressure) type vacuum breakers, and pressure type vacuum breakers shall be tested, approved, and listed in accordance with FCCHR-01. Backflow preventers with intermediate atmospheric vent shall be in accordance with ASSE 1012. Reduced pressure principle backflow preventers shall be in accordance with ASSE 1013.

### 2.3.1 Pressure Type Vacuum Breaker

Vacuum breaker shall conform to the requirements of ASSE 1020 and shall be bronze or brass construction, with one or two check valves, vacuum relief, inlet and discharge shut-offs valves, field test cocks, and vacuum relief opening of greater diameter than unit.

### 2.3.2 Reduced Pressure Type Backflow Preventers

Backflow preventers shall be 1032 kPa flanged cast iron, bronze, or brass, mounted gate valve and strainer, 304 stainless steel or bronze, internal parts. Total pressure drop through complete assembly shall be a maximum of 70 kPa at rated flow. Piping shall be red brass pipe and fittings. Strainers shall be bronze or brass construction with gasket caps. Units shall have 200-mesh stainless steel screen elements.

## 2.4 SPRINKLER HEADS

### 2.4.1 General

Heads shall be constructed of brass or high-impact plastic. Heads shall consist of a body, nozzle, and any parts necessary to the items function.

### 2.4.2 Rotary

Rotary heads shall be one of the following types: impact drive, gear drive, cam drive, or ball drive. Rotary heads shall be pop-up type.

### 2.4.3 Spray

Spray heads shall be pop-up or permanent shrub type. Pop-up shall be a minimum of 76 mm in turfed areas and above plantings in landscaped areas.

## 2.5 VALVES

### 2.5.1 General

Valves shall be constructed of brass, bronze, a combination of the two, stainless steel, or high-impact plastic except as otherwise specified for valves 3 inches and larger.

### 2.5.2 Remote Control Valves

Valves shall be electric, 24 V., normally closed solenoid actuated, diaphragm type. Valves shall be equipped with a flow adjustment stem for manual closing.

### 2.5.3 Gate Valves

Bronze gate valves smaller than 75 mm shall conform to MSS SP-80, Type 1, Class 150. Valves 3 inches and larger shall be iron body, bronze mounted and shall conform to AWWA C 509.

### 2.5.4 Quick Coupler Valves

Valves shall be of metal construction with weighted cover. Cover shall be lockable with two keys furnished for each type of valve provided. Quick coupler valves shall be furnished with two valve keys for hose connection.

### 2.5.5 Manual Drain Valve

Valves shall be brass or bronze globe valves conforming to MSS SP-80.

### 2.5.6 Automatic Drain Valves

Valves shall be spring-loaded, plunger type.

## 2.6 CONTROLLER

Controller shall conform to the requirements of NEMA ICS 2 with 120-volt single phase service, operating with indicated stations, and grounded chassis. Enclosure shall conform to NEMA ICS 6 Type 3R, with locking hinged cover, wall-mounted. Controller shall be programmed for various schedules by setting switches and dials equipped with the following features:

- (a) Adjustable clock monitors.
- (b) 14-day calendar cycle.
- (c) Sequence timer with variable time (independently variable for each zone (station), minimum time limit of not more than 5 minutes and maximum time of not less than 30 minutes for spray zones and 60 minutes for rotary zones.
- (d) Semi-automatic performance: Automatic cycle can be started manually without disturbing clock setting. Reset for the next scheduled operation after completion of the manual-initiated cycle shall be automatic.
- (e) Manual operation of each zone (station), at random or in sequence independent of the automatic timer.
- (f) Master switch which can prevent the automatic cycle from starting without affecting the pre-set program.
- (g) Zone (station) omit: Zones can be omitted from the automatic or semi-automatic watering cycle.
- (h) Compact design with all programming and operational settings easily made with switches, knobs, keyboard, etc., on the face.
- (i) Instructions for field servicing.
- (j) List of repair parts and their availability.

(k) Controller and automatic valves shall be provided from same manufacturer.

(l) Dual programming which allows any zone to be omitted from the automatic or semi-automatic cycle on any day or days of the calendar program.

(m) Automatic rain shutoff device.

## 2.7 CONTROL WIRES

Electrical control wires shall be type UF or TW, U.L. approved. Wire shall be minimum 14 gage with common ground.

## 2.8 VALVE BOXES

Boxes shall be high impact-strength plastic.

## 2.9 EXTRA STOCK

The following extra stock shall be provided: Two sprinkler heads of each size and type, two valve keys for operating manual valves, two wrenches for removing and installing each type of head, two quick coupler keys and hose swivels, and four irrigation controller housing keys.

## 3 EXECUTION

### 3.1 INSTALLATION:

#### 3.1.1 Trenching

Sprinkler mains, laterals, and control wires shall be installed in common trenches wherever possible. Wiring shall be separated from metal pipe a minimum of 150 mm to avoid possibility of current leakages and short circuits. Trenching shall be performed as specified in SECTION 02222. Mains shall be installed a minimum of 600 mm below finished grade. Headers and laterals shall be a minimum of 300 mm below finished grade. Soft, spongy, or otherwise unstable material that will not provide a firm foundation for the pipe shall be removed and replaced with satisfactory fill material as defined therein.

#### 3.1.2 Backfilling

After piping has been tested according to paragraph TESTING, trenches shall be cleared of trash and debris. Material for backfilling shall be satisfactory fill material, properly moistened to obtain optimum compaction and compacted by hand or machine tampers to density of undisturbed adjacent earth or compacted fill.

#### 3.1.3 Piping

##### 3.1.3.1 General:

Joints connecting pipe of differing materials shall be made in accordance with the manufacturer's recommendations using approved transition fittings or procedures.

Insulating joints shall be installed between non-threaded ferrous and nonferrous metallic pipe, fittings and valves. Insulating joints shall consist of a sandwich-type flange insulating gasket of the dielectric type, insulating washers, and insulating sleeves for flange bolts. Insulating gaskets shall be full faced with outside diameter equal to the flange outside diameter. Bolt insulating sleeves shall be full length. Units shall be of a shape to prevent metal-to-metal contact of dissimilar metallic piping elements.

Dielectric fittings shall be installed between threaded ferrous and nonferrous metallic pipe, fittings and valves. Dielectric fittings shall prevent metal-to-metal contact of dissimilar metallic piping elements and shall be suitable for the required working pressure. Dielectric unions shall be encapsulated in a field-poured coal-tar covering, with at least 3 mm thickness of coal tar over all fitting surfaces.

#### 3.1.3.2 Flushing

When the pipe lines are connected and the sprinkler risers in place, but before any heads are installed, the control valves shall be opened and the full head of water used to flush out the system.

#### 3.1.3.3 Crossings

Piping shall be jacked or pulled under existing paving wherever possible to prevent cutting of pavement. Where cutting is necessary, pavement shall be cut smoothly to straight lines 150 mm wider than the trench. Pavement shall be replaced in accordance with the applicable specifications or as approved. Jacking or pulling of plastic pipe shall not abrade or groove the pipe.

#### 3.1.3.4 Pitch

Mains shall be pitched down not less than 6 mm in 2.5 meters in the direction of drainage valves. Laterals and headers shall be pitched toward the automatic drain valves at not less than 3 mm in 2.5 meters .

#### 3.1.3.5 Copper

Joints shall be compression-pattern flared. The flared end tube shall be pulled tightly against the tapered part of the fitting by a nut which is part of the fitting, so there is metal-to-metal contact.

#### 3.1.3.6 PVC

Pipe shall be installed in accordance with manufacturer's instructions or as hereinafter noted.

Threaded joints shall be made with Schedule 80 pipe only. Threaded joints shall be made using a non-lubricating, non-hardening joint sealing compound as recommended by the manufacturer. Thread tape shall not be used. Joints shall be tightened to not less than one nor more than two turns past finger tight.

Elastomeric-gasket push-on joints shall be made in accordance with ASTM D 3139 and the manufacturer's instructions

Solvent cement joints shall be made in accordance with ASTM D 2855 and the manufacturer's instructions.

#### 3.1.4 Backflow Prevention Device

Backflow prevention device shall be installed in accordance with the applicable paragraphs of the National Standard Plumbing Code.

#### 3.1.5 Sprinkler Heads

Sprinkler heads shall be flush with or not more than 50 mm above finished grade upon completion of grading, seeding or sodding, and rolling of grass areas. Adjustable risers may be used to accomplish this adjustment.

#### 3.1.6 Valves

Gate valves, remote control valves, and manual drain valves shall be installed with extension valve boxes with tops set flush or not more than 50 mm above finished grade. Manual drain valves shall drain into sump pits made of gravel, sufficiently large in size to accommodate the volume of water released.

Automatic drain valves shall be furnished at all low points within a zone but no closer than 300 mm from the last head. Valves shall be installed at 45 degrees below horizontal into a gravel sump or as recommended by the manufacturer. Sump shall be of sufficient size to accommodate the water released.

#### 3.1.7 Controller

Controller shall be installed at the location shown.

#### 3.1.8 Control Wiring

Control wiring shall be sleeved in plastic or galvanized steel conduit beneath sidewalk or pavement. The conduit shall extend 300 mm beyond the edges. Wiring shall be installed a minimum of 300 mm below finished grade to the side of or below piping where possible. All main line piping shall have two spare wires installed its entire length and to the automatic controller.

Looped slack at valves shall be provided for electrical wiring. Wires shall be snaked in trenches and shall be tied in bundles at 2.5 meters intervals.

Electrical control wire splices shall be allowed only on runs more than 127 meters long.

### 3.2 TESTING

#### 3.2.1 Notification

Contracting Officer shall be present at all phases of testing and shall be notified 24 hours in advance of testing.



### 3.2.2 Hydrostatic Testing

Water piping and valves shall be tested to a hydrostatic pressure of 689 kPa before piping is covered with earth. Piping must be tight at this pressure. Piping may be tested in sections to expedite the work.

### 3.2.3 Final Testing

Final testing shall show proper operation of all components and actual measured application rates at representative and selected locations.

## SECTION 02870

## SITE FURNISHINGS

## 1 GENERAL

## 1.1 STANDARD PRODUCTS

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 5 years prior to bid opening.

## 1.2 GENERAL REQUIREMENTS

Supplementary parts necessary to complete each item shall be included even though such work is not shown definitely or specified. The Contractor shall furnish to the proper trades, all anchors, sockets, or fastenings required for securing items to other construction. Details and specifications of items for which standard products are available, are representative guides of requirements for such items. Standard products, generally meeting such requirements, will be accepted, if details of construction and installation are approved by the Contracting Officer.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-01 Data

Mfr data; FIO.

Manufacturer's data for items specified.

## SD-04 Drawings

Manufacturer's drawings; FIO.

Detailed shop drawings consisting of catalog cuts, design and erection drawings.

## SD-14 Samples

Manufacturer's color sample; GA.

One small, mailable sample of each proposed item.

## 2 PRODUCTS

## 2.1 GENERAL

Site furnishings shall be constructed of precast concrete. Units shall be shop fabricated and finished.

## 2.2 MODULAR CONCRETE FURNITURE

Modular furniture shall consist of concrete bases and seat components. Bases for seats and planters shall be type SS-B, and seat shall be type SS-4, or approved equal, as manufactured by Petersen Manufacturing Co. Inc., Leisure Products Division, Dennison IA. (Tel. 1 800 832-7383). Bases shall be approximately 610 mm square by 305 mm high and approximately 110 Kg. Seats shall be approximately 610 mm wide by 1 219 mm long by 50 mm thick and approximately 91 Kg.

## 2.3 WASTE RECEPTACLE

Waste receptacle shall be type TC-SF-22 as manufactured by Peterson Manufacturing or equal. Receptacle shall be exposed aggregate finish with removable top and attached security cable. Receptacle shall be equipped with plastic liner. Approximate dimensions shall be 914 mm high by 559 mm wide by 737 mm long with an approximate weight of 290 Kg.

## 2.4 FINISH

Modular bases and receptacles shall have an exposed aggregate finish similar to Petersen Manufacturing Brown Etch or equivalent. Modular seats shall have a smooth concrete finish similar to Peterson Lite Brown or equivalent.

## 3 EXECUTION

### 3.1 INSTALLATION

Installation of site furnishings shall be as shown on the drawings and in accordance with manufacturer's written instructions.

-- End of Section --

## SECTION 02935

## TURF

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 977 (1991) Emulsified Asphalt

ASTM D 2028 (1976; Rev. 1992) Cutback Asphalt (Rapid-Curing Type)

## AMERICAN SOD PRODUCERS

## ASSOCIATION, INC. (ASPA)

ASPA-01 (1988) Guideline Specifications to Turfgrass Sodding

## COMMERCIAL ITEM DESCRIPTIONS (CID)

CID A-A-1909 (Basic) Fertilizer

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having a "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

## SD-01 Data

Manufacturer's Catalog Data; FIO. Chemical Treatment Plan; FIO.

Manufacturer's literature discussing physical characteristics, application and installation instructions for erosion control material, and for chemical treatment material. Chemical Treatment Plan with proposed sequence of chemical treatment work. The common name, chemical composition, formulation, concentration, rate and method of application for all materials furnished; and the name and license of the state certified applicator(s) shall be included.

## SD-13 Certificates

Certificates of Compliance; FIO.

Prior to the delivery of materials, certificates of compliance for the materials listed below shall be submitted certifying that materials meet the requirements specified.

- a. Seed: Mixture percentage, pure live seed, weed seed content, germination.
- b. Sod: Species, mixture percentage, percent purity.
- c. Sprigs: Cultivar, genetic purity.
- d. Fertilizer: Chemical analysis composition percent.
- e. Lime: Chemical analysis.
- f. Asphalt Adhesive
- g. Chemical Treatment Material: For EPA registration and uses.

### 1.3 SOURCE INSPECTIONS

Sod material will be subject to inspection by the Contracting Officer at the growing site.

### 1.4 DELIVERY AND STORAGE

#### 1.4.1 Delivery

##### 1.4.1.1 Fertilizer and Lime

Delivery of fertilizer and lime to the site shall be in original, unopened containers bearing manufacturer's chemical analysis. Instead of containers, fertilizer and lime may be furnished in bulk.

##### 1.4.1.2 Chemicals

Chemical treatment materials shall be delivered to the site in the original unopened containers with legible labels indicating the Environmental Protection Agency (EPA) registration number and the manufacturer's registered uses.

#### 1.4.2 Storage

Materials shall be stored in areas designated by the Contracting Officer. Sod shall be lightly sprinkled with water, covered with moist burlap, straw, or other covering; and protected from drying and exposure to wind and direct sunlight until planted. Covering for sod shall allow air to circulate and prevent internal heat build-up.

Seed, lime, and fertilizer shall be stored in cool, dry locations away from contaminants.

Chemical treatment materials shall not be stored with other turfing materials.

## 2 PRODUCTS

### 2.1 MATERIALS

#### 2.1.1 Sod

Nursery-grown sod shall be State-certified nursery-grown sod as classified by applicable state laws and as specified in ASPA-01, Section IV. Sod materials shall conform to ASPA-01. Sod anchors shall be as recommended by the sod supplier. Grass species shall be proportioned as follows:

Botanical Name: Cynodon Dactylon

Common Name: Common bermuda

Mixture Percent: 100

#### 2.1.2 Topsoil

Topsoil shall be natural, friable surface soil possessing the characteristics of representative soils in the vicinity that produce heavy growth of crops, grass, or other vegetation.

#### 2.1.3 Fertilizer

Commercial grade, free flowing, uniform in composition and conforming to CID A-A-1909, Type I, Class 2 (granular or pelletized). Composition 10-20-10 or 13-13-13 (Nitrogen - phosphorus - potassium ratio)

#### 2.1.4 Asphalt Adhesive

Asphalt adhesive shall be cutback asphalt conforming to ASTM D 2028, designation RC-70 or emulsified asphalt conforming to ASTM D 977, Grade SS-1.

#### 2.1.5 Water

Water shall be of a quality suitable for irrigation.

#### 2.1.6 Chemical Treatment Material

Herbicide, insecticide, and fungicide shall be EPA registered and approved.

#### 2.1.7 Erosion Control Material

Soil erosion control shall conform to the following:

##### 2.1.7.1 Blanket

Machine produced mat of wood excelsior formed from a web of interlocking wood fibers, covered on one side with either plastic netting or twisted kraft paper cord netting.

##### 2.1.7.2 Fabric

Knitted construction of polypropylene yarn with uniform mesh openings 19 to 25 mm square with strips of biodegradable paper. Filler paper strips shall last 6 to 8 months.

#### 2.1.7.3 Net

Heavy, twisted jute mesh weighing approximately .56 kg per meter and 1200 mm wide with mesh openings of approximately 25 mm square.

#### 2.1.7.4 Chemicals

High-polymer synthetic resin or cold water emulsion of selected petroleum resins.

#### 2.1.7.5 Hydrophilic Colloids

Hydrophilic colloids shall be physiologically harmless to plant and animal life, without phytotoxic agents. Colloids shall be naturally occurring, silicate powder based, and shall form a water insoluble membrane after curing. Colloids must resist mold growth.

#### 2.1.7.6 Anchors

Erosion control material anchors shall be as recommended by the manufacturer.

### 3 EXECUTION

#### 3.1 PLANTING TIMES

Sod shall be laid from 1 April to 31 August.

#### 3.2 SITE PREPARATION

##### 3.2.1 Stripping and Placement of Topsoil

Topsoil shall be stripped and spread to a depth of at least 4 inches on areas already graded and prepared for topsoil, or when so directed, topsoil shall be transported and deposited in stockpiles convenient to areas that are to receive application of the topsoil later, or at locations indicated or specified.

Topsoil shall be stripped to a minimum depth of 6 inches and, when stored, shall be kept separate from other excavated materials and stockpiled free of roots, stones, and other undesirable materials. Upon completion of excavation or fill, topsoil or stripping conserved shall be uniformly distributed over all disturbed areas. Topsoil shall not be placed when the subgrade is frozen, excessively wet, extremely dry, excessively compacted, or in a condition detrimental to the proposed planting or grading.

##### 3.2.2 Grading

Site preparation work shall be performed only during periods when beneficial results can be obtained. When drought, excessive moisture or other unsatisfactory condition prevails, the work shall be stopped when directed. Finish grades shall be as indicated on drawings, and the placing of topsoil and the smooth grading shall be completed in accordance with Section 02222 EARTHWORK. Turf areas shall be filled as needed or have surplus soil removed to attain the finished grade. Drainage patterns shall be maintained as indicated on drawings. Soil used for repair of erosion or grade deficiencies shall conform to topsoil requirements specified in the Section

02222 EARTHWORK. Finished grade shall be 25 mm below the adjoining grade of any surfaced area. New surfaces shall be blended to existing areas. Lawn areas shall have debris and stones larger than 25 mm in any dimension removed from the surface. Field areas shall have debris and stones larger than 75 mm in any dimension removed from the surface. Finished graded areas shall be protected from damage by vehicular or pedestrian traffic and erosion.

### 3.2.3 Fertilizer Application

Fertilizer shall be applied at the manufacturer's recommended rate. Fertilizer shall be incorporated into the soil to a minimum depth of 100 mm or may be incorporated as part of the tillage or hydroseeding operation.

### 3.2.4 Tillage

Soil shall be tilled to a minimum depth of 100 mm by plowing, disking, harrowing, rototilling or other method. On slopes 2 horizontal to 1 vertical and steeper, the soil shall be tilled to a minimum depth of 50 mm by scarifying with heavy rakes, or other method. Rototillers shall be used where soil conditions and length of slope permit. On slopes 1 horizontal to 1 vertical and steeper, no tillage is required.

### 3.3 SODDING

Areas shall be sodded as indicated. Transplanting sod shall conform to ASPA-01. When required, the sod shall be anchored by placing anchors a minimum distance of 600 mm on center with a minimum of 2 anchors per sod section. Frayed edges shall be trimmed and holes or missing corners shall be patched in the sod.

### 3.4 EROSION CONTROL

#### 3.4.1 Erosion Control Material

Erosion control material shall be applied in areas indicated and shall be installed in accordance with manufacturer's instructions.

### 3.5 PROTECTION OF TURFED AREAS

Immediately after turfing, the area shall be protected against traffic or other use by erecting barricades and providing signage as required or as directed by the Contracting Officer.

### 3.6 ESTABLISHMENT

#### 3.6.1 Duration

The turf establishment period shall commence upon completion of the last day of the turfing operation and shall continue for a period of 3 months or until all work on the entire project has been completed and accepted, whichever is later.

#### 3.6.2 Stand of Turf

Seeding shall provide a minimum of 50 grass plants per square foot with bare spots not larger than 300 mm square. Sod shall provide living turf uniform



in color and leaf texture with bare spots shall be not larger than 300 mm square square. Sprigging shall provide not less than two turf plants per square foot with bare spots shall be no larger than 450 mm square. The total bare spots shall not exceed 2 percent of the total turfed area.

### 3.6.3 Maintenance

#### 3.6.3.1 Repair

Turf shall be reestablished as specified herein for eroded, damaged, or barren areas. Mulch shall be repaired or replaced as required.

#### 3.6.3.2 Mowing

Turfed areas shall be mowed to a minimum height of 38 mm when the average height of the turf becomes 50 mm. Clippings shall be removed when the amount of cut turf is heavy enough to damage the turfed areas.

#### 3.6.3.3 Watering

Watering shall be started immediately after completing each day of sodding or sprigging and within 7 days after seeding. Water shall be applied at the rate sufficient to ensure moist soil conditions to a minimum depth of 25 mm. Run-off and puddling shall be prevented.

Watering shall be at intervals to obtain a moist soil condition to a minimum depth of 25 mm. Frequency of watering and quantity of water shall be adjusted in accordance with the growth of the turf.

#### 3.6.3.4 Post-Fertilization

Fertilizer shall be applied at a rate to provide 2.5 kg of available nitrogen per 1000 square meters 30 days after planting is performed but not after the beginning of winter dormancy.

#### 3.6.3.5 Chemical Treatment

When a pest, disease, or weedy growth becomes apparent during the Turf Establishment Period, a state certified applicator shall apply required chemicals in accordance with EPA label restrictions and recommendations. Hydraulic equipment for the liquid application of chemicals shall be provided with a leak-proof tank, positive agitation methods, controlled application pressure and metering gauges. Pre-emergent herbicides shall not be used.

### 3.7 FINAL ACCEPTANCE

At the end of the turf establishment period, a final inspection will be made. Final acceptance of the turf will be based upon a stand of turf as defined above. Rejected areas shall be replanted or repaired as directed.

## SECTION 02950

## LANDSCAPING

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN ASSOCIATION OF NURSERYMEN (AAN)

AAN-01 (1990) American Standard for Nursery Stock

## COMMERCIAL ITEM DESCRIPTIONS (CID)

CID A-A-1909 (Basic) Fertilizer

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

## SD-01 Data

Application of Pesticide Material; FIO.

A list of the proposed pesticide application equipment to be used in performance of the planting work, including descriptive data and calibration tests.

## SD-08 Statements

Delivery Schedule; FIO.

Pesticide Treatment Plan; FIO.

a. Delivery Schedule at least 10 days prior to the intended date of the first delivery.

b. Pesticide Treatment Plan, giving proposed sequence of pesticide treatment work, before work is started. The pesticide trade name, chemical composition, formulation, concentration, application rate of active ingredients and methods of application for all materials furnished, and the name and state license number of the state certified applicator shall be included.

## SD-13 Certificates

Pesticide; FIO.

Certificates of compliance certifying that materials meet the requirements specified, prior to the delivery of materials. Reports for the following materials shall be included.

## SD-18 Records

Maintenance Report; GA.

Maintenance Instructions; GA.

a. Maintenance Report. Written record of maintenance work performed and quantity of plant losses and replacements.

b. Maintenance Instruction. Written instructions for year-round care of installed plants.

## 1.3 SOURCE INSPECTIONS

## 1.3.1 Plant Materials

Plant materials shall be subject to inspection at the growing site by the Contracting Officer.

## 1.4 SHIPMENT, DELIVERY, INSPECTION, STORAGE, AND HANDLING

## 1.4.1 Shipment

## 1.4.1.1 Preparation

Digging and preparation for shipment shall be done in a manner that will not cause shock or damage to branches, trunk, or root systems.

a. Balled and Burlapped (BB) Plants: Ball size and ratio shall be provided as recommended by AAN-01. The ball shall be of a diameter and depth to encompass enough fibrous and feeding root system necessary for the full recovery of the plant. Removal shall be accomplished by hand digging or mechanical devices. Center the plant stem or trunk in the ball and clean cut all roots at the ball surface. No roots shall be pulled from the ground. The root ball shall be completely wrapped with burlap or other suitable material and securely laced with twine.

b. Container-Grown (C) Plants: Container size shall be provided as recommended by AAN-01. Plants shall be grown in a container sufficiently long for new fibrous roots to have developed and for root mass to retain its shape and hold together when removed from container. Container shall be sufficiently rigid to hold ball shape and protect root mass during shipping.

## 1.4.1.2 Antidesiccant Application

Plants shall be sprayed with an antidesiccant as leaf budding occurs or when plant material has soft growth.

## 1.4.2 Delivery

## 1.4.2.1 Identification

Plants shall be identified with durable waterproof labels and weather-resistant ink. Plants shall have attached labels stating the correct plant name and size.

#### 1.4.2.2 Protection During Delivery

Plants shall be protected during delivery to prevent desiccation of the plant or damage to the roots or balls. Branches of plants shall be protected by tying-in the branches and covering all exposed branches.

#### 1.4.2.3 Soil Conditioner

Soil amendments shall be delivered to the site in the original, unopened containers bearing the manufacturer's chemical analysis. In lieu of containers, soil amendments may be furnished in bulk.

#### 1.4.2.4 Pesticide

Pesticide materials shall be delivered to the site in the original unopened containers bearing legible labels indicating the Environmental Protection Agency (EPA) registration numbers and the registered uses.

#### 1.4.3 Inspection

Plant material shall be inspected upon arrival at the jobsite by the Contracting Officer for conformity to the paragraph PLANTS and paragraph Shipment, and any unacceptable plant material shall be removed from the jobsite.

#### 1.4.4 Storage

##### 1.4.4.1 Plant Storage

Plants not installed on the day of arrival at the site shall be stored and protected in areas designated by the Contracting Officer. Plants shall be protected from exposure to wind and shall be shaded from the sun. Covering that will allow air to circulate and prevent internal heat from building up shall be provided. Bare-root plants shall be heeled-in. All plants shall be kept in a moist condition by watering with a fine mist spray until planted.

##### 1.4.4.2 Storage of Other Materials

Soil amendments shall be stored in dry locations away from contaminants. Pesticide materials shall not be stored with other landscape materials. Storage of materials shall be in areas designated or as approved by the Contracting Officer.

#### 1.4.5 Handling

Care shall be taken to avoid injury to plants. Materials shall not be dropped from vehicles. Balled and burlapped plants shall be handled carefully to avoid cracking or breaking the earth ball and container-grown plants shall be handled by the container. Plants shall not be handled by the trunk or stems.

#### 1.4.6 Time Limitations

a. Mulch: Limitation of time between installing plant and placing mulch is 48 hours.

b. Trunk Wrap: Limitation of time between installing deciduous trees and wrapping the trunks is 24 hours.

## 1.5 WARRANTY

Furnished plants shall be guaranteed to be in a vigorous growing condition for a period of 12 months regardless of the contract time period. A plant shall be replaced one time under this guarantee. A written calendar time period for the guarantee of plant growth shall be furnished to the Contracting Officer.

## 2 PRODUCTS

### 2.1 PLANTS

#### 2.1.1 Varieties

Plants shall be nursery grown or plantation grown stock conforming to AAN-01 and shall be of the varieties specified in the plant list bearing botanical names listed in one or more of the publications listed under "Nomenclature" in AAN-01.

#### 2.1.2 Substitutions

Substitutions will not be permitted without written request from the Contractor for approval by the Contracting Officer.

#### 2.1.3 Growing Conditions

Plants shall be grown under climatic conditions similar to those in the locality of the project.

#### 2.1.4 Quality

Well shaped, well grown, vigorous, healthy plants having healthy and well branched root systems shall be provided. Plants shall be provided free from disease, harmful insects and insect eggs, sun-scald injury, disfigurement and abrasion. Plants shall be provided that are typical of the species or variety and conforming to standards as set forth in AAN-01 and as specified herein.

##### 2.1.4.1 Shade and Flowering Trees

A height relationship to caliper shall be provided as recommended by AAN-01. Height of branching should bear a relationship to the size and variety of tree specified and with the crown in good balance with the trunk. Trees shall not be "poled" or the leader removed.

a. Single stem: Trunk shall be reasonably straight and symmetrical with crown and have a persistent main leader.

b. Multi-stem: All countable stems, in aggregate, shall average the size specified. To be considered a stem, there should be no division of the trunk which branches more than six inches from ground level.

c. Specimen: A plant shall be provided that is well branched and pruned naturally according to the species. The form of growth desired,

which may not be in accordance with natural growth habit, shall be as indicated.

#### 2.1.4.2 Coniferous Evergreen

Trees shall be provided that have the height-to-spread ratio as recommended by AAN-01. Trees shall not be "poled" or the leader removed. An acceptable plant shall be exceptionally heavy, well shaped and trimmed to form a symmetrical and tightly knit plant. The form of growth desired shall be as indicated.

#### 2.1.4.3 Broadleaf Evergreen

Plants shall be provided that have ratio of height-to-spread as recommended by AAN-01. An acceptable plant shall be well shaped and recognized by the trade as typical for the variety grown in the region.

#### 2.1.5 Size

Plants shall be furnished in sizes indicated. Plants larger in size than specified may be provided at no additional cost to the Government.

#### 2.1.6 Measurement

Plant measurements shall be in accordance with AAN-01.

### 2.2 TOPSOIL

Topsoil shall be the existing surface soil stripped as specified in Section 02225 and stockpiled on the site. Additional topsoil, if required, beyond that available from stripping operations, shall be delivered and shall be approved by the Contracting Officer.

### 2.3 SOIL CONDITIONER

Soil conditioner shall be a commercial conditioner of organic material such as 'Milorganite' or 'Back to Earth'.

### 2.4 FERTILIZER

Fertilizer shall be commercial grade, free flowing, uniform in composition and conforming to CID A-A-1909. Consists of nitrogen-phosphorous-potassium ratio : 10 percent nitrogen 20 percent phosphorous, and 10 percent potassium.

### 2.5 MULCH

Organic mulch materials shall be shredded cypress or eucalyptus.

### 2.6 TRUNK WRAPPING MATERIAL

Tree wrap shall be two thicknesses of crinkled paper cemented together with a layer of bituminous material. Wrapping material shall be a minimum of 100 mm in width and have a stretch factor of 33-1/3 percent. Twine for tying shall be lightly tarred medium or coarse sisal yarn.

## 2.7 GUYING AND STAKING MATERIAL

As shown.

## 2.8 WATER

Water shall not contain elements toxic to plant life.

## 2.9 ANTIDESICCANT

Antidesiccant shall be an emulsion that will provide a film over plant surfaces permeable enough to permit transpiration, and shall not damage the plant.

## 2.10 PESTICIDE

Pesticide material shall be labeled for use and applied only as registered by EPA and approved.

# 3 EXECUTION

## 3.1 EXAMINATION

### 3.1.1 Verify Grades

The Contracting Officer shall verify the finished grades are as indicated on drawings, and the placing of topsoil and smooth grading has been completed in accordance with Section 02225.

### 3.1.2 Underground Obstructions to Planting

The location of underground utilities and facilities shall be verified. Damage to underground utilities and facilities shall be repaired at the Contractor's expense.

## 3.2 SITE PREPARATION

### 3.2.1 Layout

Plant material locations and bed outlines shall be staked on the project site before any excavation is made. Plant material locations may be adjusted by the Contracting Officer to meet field conditions.

### 3.2.2 Protection of Existing Vegetation

If lawns have been established prior to planting operations, the surrounding turf shall be covered before excavations are made in a manner that will protect turf areas. Existing trees, shrubbery, and beds that are to be preserved shall be barricaded in a manner that will effectively protect them during planting operations.

## 3.3 EXCAVATION

### 3.3.1 Obstructions Below Ground or Poor Drainage

When obstructions below ground or poor drainage affect the contract operation, proposed adjustments to plant location, type of plant and

planting method or drainage correction shall be submitted to and approved by the Contracting Officer.

### 3.3.2 Turf Removal

Where planting beds occur in existing turf areas, the turf shall be removed to a depth that will ensure the removal of the entire root system.

### 3.3.3 Plant Pits

Plant pits shall be dug to produce vertical sides and flat, uncompacted bottoms. When pits are dug with an auger and the sides of the pits become glazed, the glazed surface shall be scarified. The size of plant pits shall be as shown.

## 3.4 PLANTING TIMES AND CONDITIONS

### 3.4.1 Deciduous Planting Time

Install deciduous plants from 1 March thru 15 June and 15 Nov thru 30 Dec.

### 3.4.2 Evergreen Planting Time

Install evergreen plants from 1 March thru 15 June and 15 Nov thru 15 Dec.

### 3.4.3 Container Grown Planting Time

Install container grown plants from 1 March thru 15 Dec.

### 3.4.4 Planting Conditions

Planting operations shall be performed only during periods when beneficial results can be obtained. When drought, excessive moisture or other unsatisfactory conditions prevail, the work shall be stopped when directed. When special conditions warrant a variance to the planting operations, proposed planting times shall be submitted to and approved by the Contracting Officer.

## 3.5 INSTALLATION

### 3.5.1 Prepared Soil Mixture

The backfill soil mixture shall be a proportioned mixture thoroughly mixed by volume of topsoil and selected soil amendments as follows:

Existing Topsoil	50 percent of mixture
Soil Conditioner	50 percent of mixture

### 3.5.2 Setting Plants

Plants shall be set plumb and held in position until sufficient soil has been firmly placed around roots or ball. Plants shall be set in relation to surrounding grade so that they are even with the depth at which they were grown in the nursery, or container.



### 3.5.3 Fertilizer

Fertilizer shall be placed the planted area at the rate of .4877 Kg. per 100 square meters of saucer area or bedding area.

### 3.5.4 Balled and Burlapped Plants

Materials shall be removed that are metal, plastic, nylon or treated burlap, prior to backfilling. Balled and burlapped stock shall be backfilled with backfill soil mixture to approximately half the depth of the ball and then tamped and watered. Biodegradable burlap and tying material shall be carefully opened and folded back. The backfill shall be completed, tamped and watered. An earth saucer shall be formed around individual plants as shown.

### 3.5.5 Container-Grown Plants

Non-biodegradable containers shall be removed without damage to the plant or root system. Biodegradable containers shall be split. The backfill shall be completed as specified for BB plants.

### 3.5.6 Plant Beds

The existing soil shall be excavated and removed to a minimum depth shown and replaced with prepared soil mixture specified above.

### 3.5.7 Staking and Guying

As shown.

## 3.6 FINISHING

### 3.6.1 Plant Beds

Planted areas shall be uniformly edged to provide a clear-cut division line between the planted area and the adjacent turf area and to provide a shape as indicated. The entire planted area shall be raked and smoothed while maintaining the earth saucers.

### 3.6.2 Pruning

The total amount of foliage shall be pruned by one-fourth to one-third on installed trees and shrubs to compensate for loss of roots and transplanting shock. The typical growth habit of individual plants shall be retained. Clean cuts shall be made flush with the parent trunk. Improper cuts, stubs, dead and broken branches shall be removed. "Headback" cuts at right angles to the line of growth shall not be permitted. Trees shall not be poled or the leader removed, nor shall the leader be pruned or "topped off." Cuts or wounds measuring a minimum 50 mm in diameter shall be painted with the specified tree wound dressing.

### 3.6.3 Mulch

Mulch shall be spread as shown. Mulch shall be kept out of the crowns of shrubs and off buildings, sidewalks and other facilities.

#### 3.6.4 Trunk Wrap

Trees 38 mm or greater in caliper shall be wrapped with the specified material beginning at the base and extending up to the first branches. The wrapping shall be securely tied with twine at the top and bottom and at 457 mm intervals.

#### 3.6.5 Water

Plants shall be watered as necessary to maintain an adequate supply of moisture within the root zone. Run-off, puddling and wilting shall be prevented.

#### 3.6.6 Antidesiccant Application

Plants requiring further protection shall be sprayed with anti-desiccant in accordance with manufacturer's recommendations.

### 3.7 MAINTENANCE DURING PLANTING OPERATION

Installed plants shall be maintained in a healthy growing condition. Maintenance operations shall begin immediately after each plant is installed and shall continue until the plant establishment period commences. The maintenance includes watering, pruning, wound dressing, straightening and other necessary operations. Plant beds and earth saucers shall be kept free of weeds, grass and other undesired vegetation. Plants shall be checked for settlement and shall be reset proper grade as necessary. Run-off, puddling and wilting shall be prevented.

### 3.8 APPLICATION OF PESTICIDE MATERIAL

A state-certified applicator shall apply required pesticide in accordance with State EPA label restrictions and recommendations. Hydraulic equipment shall be provided for the liquid application of pesticides with a leak-proof tank, positive agitation methods, controlled application pressure and metering gauges. A pesticide treatment plan shall be provided to the Contracting Officer as specified in paragraph SUBMITTALS.

### 3.9 PLANT ESTABLISHMENT PERIOD

#### 3.9.1 Commencement

On completion of the last day of the planting operation, the plant establishment period for maintaining installed plants in a healthy growing condition shall commence and shall be in effect for the remaining contract time period not to exceed 12 months. When the planting operation extends over more than one season or there is a variance to the planting times, plant establishment periods shall be established for the work completed, as directed. Written calendar time period shall be furnished to the Contracting Officer for the beginning of the plant establishment period. When there is more than one plant establishment period, describe the boundaries of the planted area covered for each period.

### 3.9.2 Maintenance During Establishment Period

#### 3.9.2.1 General

Maintenance of plants shall include straightening plants, tightening stakes and guying material, repairing tree wrapping, protecting plant areas from erosion, maintaining erosion control material, supplementing mulch, accomplishing wound dressing, removing dead or broken tip growth by pruning, maintaining edging of beds, checking for girdling of plants and maintaining plant labels, watering, weeding, removing and replacing unhealthy plants.

#### 3.9.2.2 Water

The plants shall be watered as necessary to maintain an adequate supply of moisture within the root zone. An adequate supply of moisture is estimated to be the equivalent of one inch of absorbed water per week delivered in the form of natural rain or augmented as required by periodic waterings. Run-off, puddling and wilting shall be prevented.

#### 3.9.2.3 Weeding

Grass and weeds in earth saucers and plant beds shall not be allowed to reach a height of 75 mm before being completely removed, including the root growth.

#### 3.9.2.4 Unhealthy Plants

A plant shall be considered unhealthy or dead when the main leader has died back, or 25 percent of the crown is dead. Determine the cause for an unhealthy plant. Unhealthy or dead plants shall be removed immediately and shall be replaced as soon as seasonal conditions permit.

#### 3.9.2.5 Fertilizing

The plants shall be top-dressed at least once during the period of establishment with dry fertilizer at the rate of 5 pounds per 100 square feet of plant pit or bed area. Dry fertilizer adhering to plants shall be flushed off. The application shall be timed prior to the advent of winter dormancy.

#### 3.9.2.6 Settlement

Topsoil shall be added to maintain grade and to maintain earth saucers. Serious settlement affecting the setting of the plant in relation to the depth at which it was grown requires replanting in accordance with paragraph INSTALLATION.

#### 3.9.2.6 Pesticide Treatment

Pesticide shall be applied to trees and shrubs as required for damaging attack of insects. Treatment for pest shall be in accordance with paragraph APPLICATION OF PESTICIDE MATERIAL.

### 3.9.2.7 Maintenance Report

A written record shall be furnished to the Contracting Officer of the maintenance work performed, the quality of plant losses, cause for plant loss and replacements made on each site visit.

### 3.9.2.8 Maintenance Instruction

Written instructions shall be furnished to the Contracting Officer for year-round care of installed plants.

### 3.9.3 Replacement Plants

Plants shall be provided for replacement in accordance with paragraph PLANTS. Replacement plants shall be installed in accordance with paragraph INSTALLATION. No extended plant establishment period shall be required for replacement plants. A plant will be replaced in accordance with paragraph WARRANTY.

## 3.10 FINAL ACCEPTANCE

### 3.10.1 Preliminary Inspection

Prior to the the plant establishment period, a preliminary inspection shall be held by the Contracting Officer. Time for the inspection shall be established in writing. The quantity and type of plants installed and the acceptability of the plants in accordance with the plant establishment period shall be determined.

### 3.10.2 Final Inspection

A final inspection shall be held by the Contracting Officer to determine that deficiencies noted in the preliminary inspection have been corrected. Time for the inspection shall be established in writing. Acceptance of the planting operation is subject to the guarantee of plant growth.

## SECTION 03100

## STRUCTURAL CONCRETE FORMWORK

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## ACI INTERNATIONAL (ACI)

ACI 347R (1994) Guide to Formwork for Concrete

## AMERICAN HARDBOARD ASSOCIATION (AHA)

AHA A135.4 (1995) Basic Hardboard

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 578 (1995) Rigid, Cellular Polystyrene Thermal Insulation

## DEPARTMENT OF COMMERCE (DOC)

DOC PS 1 (1983) Construction and Industrial Plywood

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

## SD-01 Data

Design; FIO.

Design analysis and calculations for form design and methodology used in the design.

Concrete Formwork; FIO.

Manufacturer's data including literature describing form materials, accessories, and form releasing agents.

## SD-04 Drawings

Concrete Formwork; FIO.

Drawings showing details of formwork including, dimensions of fiber voids, joints, supports, studding and shoring, and sequence of form and shoring removal.

## SD-06 Instructions

Form Releasing Agents; FIO.

Manufacturer's recommendation on method and rate of application of form releasing agents.

## SD-13 Certificates

Fiber Voids; FIO.

Certificates attesting that fiber voids conform to the specified requirements.

## SD-14 Samples

Fiber Voids; FIO.

One sample unit of fiber voids prior to installation of the voids.

## 1.3 DESIGN

Formwork shall be designed in accordance with methodology of ACI 347R for anticipated loads, lateral pressures, and stresses. Forms shall be capable of producing a surface which meets the requirements of the class of finish specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. Forms shall be capable of withstanding the pressures resulting from placement and vibration of concrete.

## 1.4 STORAGE AND HANDLING

Fiber voids shall be stored above ground level in a dry location. Fiber voids shall be kept dry until installed and overlaid with concrete.

## 2 PRODUCTS

## 2.1 FORM MATERIALS

## 2.1.1 Forms For Class A and Class B Finish

Forms for Class A and Class B finished surfaces shall be plywood panels conforming to DOC PS 1, Grade B-B concrete form panels, Class I or II. Other form materials or liners may be used provided the smoothness and appearance of concrete produced will be equivalent to that produced by the plywood concrete form panels. Forms for round columns shall be the prefabricated seamless type.

## 2.1.2 Forms For Class C Finish

Forms for Class C finished surfaces shall be shiplap lumber; plywood conforming to DOC PS 1, Grade B-B concrete form panels, Class I or II; tempered concrete form hardboard conforming to AHA A135.4; other approved concrete form material; or steel, except that steel lining on wood sheathing shall not be used. Forms for round columns may have one vertical seam.

### 2.1.3 Forms For Class D Finish

Forms for Class D finished surfaces, except where concrete is placed against earth, shall be wood or steel or other approved concrete form material.

### 2.1.4 Retain-In-Place Metal Forms

Retain-in-place metal forms for concrete slabs and roofs shall be as specified in Section 05300 STEEL DECKING.

### 2.1.5 Form Ties

Form ties shall be factory-fabricated metal ties, shall be of the removable or internal disconnecting or snap-off type, and shall be of a design that will not permit form deflection and will not spall concrete upon removal. Solid backing shall be provided for each tie. Except where removable tie rods are used, ties shall not leave holes in the concrete surface less than 6 mm nor more than 25 mm deep and not more than 25 mm in diameter. Removable tie rods shall be not more than 38 mm in diameter.

### 2.1.6 Form Releasing Agents

Form releasing agents shall be commercial formulations that will not bond with, stain or adversely affect concrete surfaces. Agents shall not impair subsequent treatment of concrete surfaces depending upon bond or adhesion nor impede the wetting of surfaces to be cured with water or curing compounds.

### 2.1.7 Fiber Voids

Fiber voids shall be the product of a reputable manufacturer regularly engaged in the commercial production of fiber voids. The voids shall be constructed of double faced, corrugated fiberboard. The corrugated fiberboard shall be fabricated of wet strength paper, impregnated with paraffin, and laminated with moisture resistant adhesive, and shall have a board strength of 20 kg per square centimeter. Voids which are impregnated with paraffin after construction, in lieu of being constructed with paraffin impregnated fiberboard, are acceptable. Voids shall be designed to support not less than 4900 kg per square meter. To prevent separation during concrete placement fiber voids shall be assembled with steel or plastic banding at 1.22 meters on center maximum, or by adequate stapling or gluing as recommended by the manufacturer. Fiber voids placed under concrete slabs and that are 200 mm in depth may be heavy duty "waffle box" type, constructed of paraffin impregnated corrugated fiberboard.

## 2.2 FIBER VOID RETAINERS

### 2.2.1 Polystyrene Rigid Insulation

Polystyrene rigid insulation shall conform to ASTM C 578, Type V, VI, or VII, square edged. Size shall be 38 mm thick by 400 mm in height by 1 meter in length, unless otherwise indicated.

### 2.2.2 Precast Concrete

Precast concrete units shall have a compressive strength of not less than 17 MPa, reinforced with 150 mm by 150 mm by W1.4 WWF wire mesh, and 300 mm (height) by 1 m (length) by 40 mm (thickness) in size unless indicated.

## 3 EXECUTION

### 3.1 INSTALLATION

#### 3.1.1 Formwork

Forms shall be mortar tight, properly aligned and adequately supported to produce concrete surfaces meeting the surface requirements specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE and conforming to construction tolerance given in TABLE 1. Where concrete surfaces are to have a Class A or Class B finish, joints in form panels shall be arranged as approved. Where forms for continuous surfaces are placed in successive units, care shall be taken to fit the forms over the completed surface so as to obtain accurate alignment of the surface and to prevent leakage of mortar. Forms shall not be reused if there is any evidence of surface wear and tear or defects which would impair the quality of the surface. Surfaces of forms to be reused shall be cleaned of mortar from previous concreting and of all other foreign material before reuse. Form ties that are to be completely withdrawn shall be coated with a nonstaining bond breaker.

#### 3.1.2 Fiber Voids

Voids shall be placed on a smooth firm dry bed of suitable material so as not to be displaced vertically and shall be set tight, with no buckled cartons, in order that horizontal displacement cannot take place. Each section of void shall have its ends sealed by dipping in paraffin, with any additional cutting of voids at the jobsite to be field dipped in the same type of sealer, unless liners and flutes are completely impregnated with paraffin. Prior to placing reinforcement, the entire formed area for slabs shall be covered with a 1.22 m x 2.44 m minimum flat sheets of fiber void corrugated fiberboard. Joints shall be sealed with a moisture resistant tape having a minimum width of 75 mm. If voids are destroyed or damaged for any reason and are not capable of supporting the design load, they shall be replaced prior to placing of concrete.

#### 3.1.3 Fiber Void Retainers

Fiber void retainers shall be installed, continuously, on both sides of fiber voids placed under grade beams in order to retain the cavity after the fiber voids biodegrade.

### 3.2 CHAMFERING

Except as otherwise shown, external corners that will be exposed shall be chamfered, beveled, or rounded by moldings placed in the forms.

### 3.3 COATING

Forms for Class A and Class B finished surfaces shall be coated with a form releasing agent before the form or reinforcement is placed in final position. The coating shall be used as recommended in the manufacturer's



printed or written instructions. Forms for Class C and D finished surfaces may be wet with water in lieu of coating immediately before placing concrete, except that in cold weather with probable freezing temperatures coating shall be mandatory. Surplus coating on form surfaces and coating on reinforcing steel and construction joints shall be removed before placing concrete.

### 3.4 REMOVAL OF FORMS

Forms shall be removed in a manner that will prevent injury to the concrete and ensure the complete safety of the structure. Formwork for columns, walls, side of beams and other parts not supporting the weight of concrete may be removed when the concrete has attained sufficient strength to resist damage from the removal operation but not before at least 24 hours has elapsed since concrete placement. Supporting forms and shores shall not be removed from beams, floors and walls until the structural units are strong enough to carry their own weight and any other construction or natural loads. In no case will supporting forms or shores be removed before the concrete strength has reached 70 percent of design strengths as determined by field cured cylinders or other approved methods. This strength shall be demonstrated by job-cured test specimens, and by a structural analysis considering the proposed loads in relation to these test strengths and the strength of forming and shoring system. The job-cured test specimens for form removal purposes shall be provided in numbers as directed and shall be in addition to those required for concrete quality control. The specimens shall be removed from molds at the age of 24 hours and shall receive, insofar as possible, the same curing and protection as the structures they represent.

TABLE 1

#### TOLERANCES FOR FORMED SURFACES

1. Variations from the plumb:	In any 3 m of length -----	6 mm
a. In the lines and surfaces of columns, piers, walls and in arises	Maximum for entire length -----	25 mm
b. For exposed corner columns, control-joint grooves, and other conspicuous lines	In any 6 m of length ----- Maximum for entire length -----	6 mm 13 mm
2. Variation from the level or from the grades indicated on the drawings:	In any 3 m of length ----- In any bay or in any 6 m of length -----	6 mm 10 mm
a. In slab soffits, ceilings, beam soffits, and in arises, measured before removal of supporting shores	Maximum for entire length -----	20 mm
b. In exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines	In any bay or in any 6 m of length ----- Maximum for entire length -----	6 mm 13 mm

3.	Variation of the linear building lines from established position in plan	In any 6 m -----	13 mm
		Maximum -----	25 mm
4.	Variation of distance between walls, columns, partitions	6 mm per 3 m of distance, but not more than 13 mm in any one bay, and not more than 25 mm total variation	
5.	Variation in the sizes and locations of sleeves, floor openings, and wall opening	Minus -----	6 mm
		Plus -----	13 mm
6.	Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls	Minus -----	6 mm
		Plus -----	13 mm
7.	Footings:		
a.	Variation of dimensions in plan	Minus -----	13 mm
	when formed or plus 75 mm when placed against unformed excavation	Plus -----	50 mm
b.	Misplacement of eccentricity	2 percent of the footing width in the direction of misplacement but not more than -----	50 mm
c.	Reduction in thickness specified thickness	Minus -----	5 percent of
8.	Variation in steps:	Riser -----	3 mm
a.	In a flight of stairs	Tread -----	6 mm
b.	In consecutive steps	Riser -----	2 mm
		Tread -----	3 mm

## SECTION 03200

## CONCRETE REINFORCEMENT

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## ACI INTERNATIONAL (ACI)

ACI 318M (1995) Building Code Requirements for  
Structural Concrete and Commentary (Metric)

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 53 (1996) Pipe, Steel, Black and Hot-Dipped,  
Zinc-Coated, Welded and Seamless

ASTM A 82 (1995a) Steel Wire, Plain, for Concrete  
Reinforcement

ASTM A 184/A 184M (1996) Fabricated Deformed Steel Bar Mats for  
Concrete Reinforcement

ASTM A 185 (1994) Steel Welded Wire Fabric, Plain, for  
Concrete Reinforcement

ASTM A 497 (1995) Steel Welded Wire Fabric, Deformed,  
for Concrete Reinforcement

ASTM A 615/A 615M (1996a) Deformed and Plain Billet-Steel Bars  
for Concrete Reinforcement

ASTM A 675/A 675M (1990a; R 1995) Steel Bars, Carbon, Hot-  
Wrought, Special Quality, Mechanical  
Properties

ASTM A 706/A 706M (1995b) Low-Alloy Steel Deformed and Plain  
Bars for Concrete Reinforcement

## AMERICAN WELDING SOCIETY (AWS)

AWS D1.4 (1992) Structural Welding Code - Reinforcing  
Steel

## CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

CRSI MSP-1 (1996) Manual of Standard Practice

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

### SD-04 Drawings

Concrete Reinforcement System; GA.

Detail drawings showing reinforcing steel placement, schedules, sizes, grades, and splicing and bending details. Drawings shall show support details including types, sizes and spacing.

### SD-08 Statements

Welding; FIO.

A list of qualified welders names.

### SD-13 Certificates

Reinforcing Steel; FIO.

Certified copies of mill reports attesting that the reinforcing steel furnished contains no less than 25 percent recycled scrap steel and meets the requirements specified herein, prior to the installation of reinforcing steel.

## 1.3 WELDING

Welders shall be qualified in accordance with AWS D1.4. Qualification test shall be performed at the worksite and the Contractor shall notify the Contracting Officer 24 hours prior to conducting tests. Special welding procedures and welders qualified by others may be accepted as permitted by AWS D1.4.

## 1.4 DELIVERY AND STORAGE

Reinforcement and accessories shall be stored off the ground on platforms, skids, or other supports.

## 2 PRODUCTS

### 2.1 DOWELS

Dowels shall conform to ASTM A 675/A 675M, Grade 80. Steel pipe conforming to ASTM A 53, Schedule 80, may be used as dowels provided the ends are closed with metal or plastic inserts or with mortar.

### 2.2 FABRICATED BAR MATS

Fabricated bar mats shall conform to ASTM A 184/A 184M.

### 2.3 REINFORCING STEEL

Reinforcing steel shall be deformed bars conforming to ASTM A 615/A 615M or ASTM A 706/A 706M, grades and sizes as indicated. Cold drawn wire used for spiral reinforcement shall conform to ASTM A 82.

### 2.4 WELDED WIRE FABRIC

Welded wire fabric shall conform to ASTM A 185 or ASTM A 497.

### 2.5 WIRE TIES

Wire ties shall be 16 gauge or heavier black annealed steel wire.

### 2.6 SUPPORTS

Bar supports for formed surfaces shall be designed and fabricated in accordance with CRSI MSP-1 and shall be steel or precast concrete blocks. Precast concrete blocks shall have wire ties and shall be not less than 100 by 100 mm when supporting reinforcement on ground. Precast concrete block shall have compressive strength equal to that of the surrounding concrete. Where concrete formed surfaces will be exposed to weather or where surfaces are to be painted, steel supports within 13 mm of concrete surface shall be galvanized, plastic protected or of stainless steel. Concrete supports used in concrete exposed to view shall have the same color and texture as the finish surface. For slabs on grade, supports shall be precast concrete blocks, plastic coated steel fabricated with bearing plates, or specifically designed wire-fabric supports fabricated of plastic.

## 3 EXECUTION

### 3.1 REINFORCEMENT

Reinforcement shall be fabricated to shapes and dimensions shown and shall conform to the requirements of ACI 318M . Reinforcement shall be cold bent unless otherwise authorized. Bending may be accomplished in the field or at the mill. Bars shall not be bent after embedment in concrete. Safety caps shall be placed on all exposed ends of vertical concrete reinforcement bars that pose a danger to life safety. Wire tie ends shall face away from the forms.

#### 3.1.1 Placement

Reinforcement shall be free from loose rust and scale, dirt, oil, or other deleterious coating that could reduce bond with the concrete. Reinforcement shall be placed in accordance with ACI 318M at locations shown plus or minus one bar diameter. Reinforcement shall not be continuous through expansion joints and shall be as indicated through construction or contraction joints. Concrete coverage shall be as indicated or as required by ACI 318M . If bars are moved more than one bar diameter to avoid interference with other reinforcement, conduits or embedded items, the resulting arrangement of bars, including additional bars required to meet structural requirements, shall be approved before concrete is placed.

### 3.1.2 Splicing

Splices of reinforcement shall conform to ACI 318M and shall be made only as required or indicated. Splicing shall be by lapping or by mechanical or welded butt connection; except that lap splices shall not be used for bars larger than No. 11 unless otherwise indicated. Welding shall conform to AWS D1.4. Welded butt splices shall be full penetration butt welds. Lapped bars shall be placed in contact and securely tied or spaced transversely apart to permit the embedment of the entire surface of each bar in concrete. Lapped bars shall not be spaced farther apart than one-fifth the required length of lap or 150 mm. Mechanical butt splices shall be in accordance with the recommendation of the manufacturer of the mechanical splicing device. Butt splices shall develop 125 percent of the specified minimum yield tensile strength of the spliced bars or of the smaller bar in transition splices. Bars shall be flame dried before butt splicing. Adequate jigs and clamps or other devices shall be provided to support, align, and hold the longitudinal centerline of the bars to be butt spliced in a straight line.

### 3.2 WELDED-WIRE FABRIC PLACEMENT

Welded-wire fabric shall be placed in slabs as indicated. Fabric placed in slabs on grade shall be continuous between expansion, construction, and contraction joints. Fabric placement at joints shall be as indicated. Lap splices shall be made in such a way that the overlapped area equals the distance between the outermost crosswires plus 50 mm. Laps shall be staggered to avoid continuous laps in either direction. Fabric shall be wired or clipped together at laps at intervals not to exceed 1.2 m. Fabric shall be positioned by the use of supports.

### 3.3 DOWEL INSTALLATION

Dowels shall be installed in slabs on grade at locations indicated and at right angles to joint being doweled. Dowels shall be accurately positioned and aligned parallel to the finished concrete surface before concrete placement. Dowels shall be rigidly supported during concrete placement. One end of dowels shall be coated with a bond breaker.

## SECTION 03250

## EXPANSION JOINTS, CONTRACTION JOINTS, AND WATERSTOPS

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION  
OFFICIALS (AASHTO)

AASHTO T 111 (1983) Inorganic Matter or Ash in Bituminous  
Materials

AMERICAN HARDBOARD ASSOCIATION (AHA)

AHA A135.4 (1995) Basic Hardboard

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 919 (1984; R 1992) Standard Practice for Use of  
Sealants in Acoustical Applications

ASTM C 920 (1994) Elastomeric Joint Sealants

ASTM D 4 (1986; R 1993) Bitumen Content

ASTM D 6 (1980; R 1990) Loss on Heating of Oil and  
Asphaltic Compounds

ASTM D 412 (1992) Vulcanized Rubber and Thermoplastic  
Rubbers and Thermoplastic Elastomers -  
Tension

ASTM D 471 (1995) Rubber Property - Effect of Liquids

ASTM D 1190 (1994) Concrete Joint Sealer, Hot-Poured  
Elastic Type

ASTM D 1191 (1984; R 1994) Test Methods for Concrete  
Joint Sealers

ASTM D 1751 (1983; R 1991) Preformed Expansion Joint  
Filler for Concrete Paving and Structural  
Construction (Nonextruding and Resilient  
Bituminous Types)

ASTM D 1752 (1984; R 1992) Preformed Sponge Rubber and  
Cork Expansion Joint Fillers for Concrete  
Paving and Structural Construction

ASTM D 2628 (1991) Preformed Polychloroprene Elastomeric  
Joint Seals for Concrete Pavements

ASTM D 2835	(1989; R 1993) Lubricant for Installation of Preformed Compression Seals in Concrete Pavements
ASTM D 5249	(1992) Backer Material for Use With Cold and Hot-Applied Joint Sealants in Portland-Cement Concrete and Asphalt Joints

## CORPS OF ENGINEERS (COE)

COE CRD-C 513	(1974) Corps of Engineers Specifications for Rubber Waterstops
COE CRD-C 572	(1974) Corps of Engineers Specifications for Polyvinylchloride Waterstops

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

## SD-01 Data

Preformed Expansion Joint Filler; FIO.  
Sealant; FIO.  
Waterstops; FIO.

Manufacturer's literature, including safety data sheets, for preformed fillers and the lubricants used in their installation; field-molded sealants and primers (when required by sealant manufacturer); preformed compression seals; and waterstops.

## SD-04 Drawings

Waterstops; FIO.

Shop drawings and fabrication drawings provided by the manufacturer or prepared by the Contractor.

## SD-06 Instructions

Preformed Expansion Joint Filler; FIO.  
Sealant; FIO.  
Waterstops; FIO.

Manufacturer's recommended instructions for installing preformed fillers, field-molded sealants; preformed compression seals; and waterstops; and for splicing non-metallic waterstops.



## SD-13 Certificates

Preformed Expansion Joint Filler; FIO.  
Sealant; FIO.  
Waterstops; FIO.

Certificates of compliance stating that the joint filler and sealant materials and waterstops conform to the requirements specified.

## SD-14 Samples

Preformed Compression Seals and Lubricants; FIO.

Specimens identified to indicate the manufacturer, type of material, size and quantity of material, and shipment or lot represented. Each sample shall be a piece not less than 3 m of 25 mm nominal width or wider seal or a piece not less than 4 m of compression seal less than 25 mm nominal width. One liter of lubricant shall be provided.

Field-Molded Sealant and Primer; FIO.

Four liters of field-molded sealant and one liter of primer (when the sealant manufacturer recommends primer) identified to indicate manufacturer, type of material, quantity, and shipment or lot represented.

Non-metallic Waterstops and Splices; FIO.

Specimens identified to indicate manufacturer, type of material, size, quantity of material, and shipment or lot represented. Each sample shall be a piece not less than 300 mm long cut from each 61 m of finished waterstop furnished, but not less than a total of 1 m of each type, size, and lot furnished. One splice sample of each size and type for every 50 splices made in the factory and every 10 splices made at the job site. The splice samples shall be made using straight run pieces with the splice located at the mid-length of the sample and finished as required for the installed waterstop. The total length of each splice shall be not less than 300 mm long.

## 1.3 DELIVERY AND STORAGE

Material delivered and placed in storage shall be stored off the ground and protected from moisture, dirt, and other contaminants. Sealants shall be delivered in the manufacturer's original unopened containers. Sealants whose shelf life has expired shall be removed from the site.

## 2 PRODUCTS

## 2.1 CONTRACTION JOINT STRIPS

Contraction joint strips shall be 3 mm thick tempered hardboard conforming to AHA A135.4, Class 1. In lieu of hardboard strips, rigid polyvinylchloride (PVC) or high impact polystyrene (HIPS) insert strips specifically designed to induce controlled cracking in slabs on grade may be used. Such insert strips shall have removable top section.

## 2.2 PREFORMED EXPANSION JOINT FILLER

Expansion joint filler shall be preformed material conforming to ASTM D 1751 or ASTM D 1752. Unless otherwise indicated, filler material shall be 10 mm thick and of a width applicable for the joint formed. Backer material, when required, shall conform to ASTM D 5249.

## 2.3 SEALANT

Joint sealant shall conform to the following:

### 2.3.1 Preformed Polychloroprene Elastomeric Type

ASTM D 2628.

### 2.3.2 Lubricant for Preformed Compression Seals

ASTM D 2835.

### 2.3.3 Hot-Poured Type

ASTM D 1190 tested in accordance with ASTM D 1191.

### 2.3.4 Field Molded Type

ASTM C 920, Type M for horizontal joints or Type NS for vertical joints, Class 25, and Use NT. Bond breaker material shall be polyethylene tape, coated paper, metal foil or similar type materials. The back-up material shall be compressible, non-shrink, nonreactive with sealant, and non-absorptive material type such as extruded butyl or polychloroprene rubber.

## 2.4 WATERSTOPS

Intersection and change of direction waterstops shall be shop fabricated.

### 2.4.1 Non-Metallic

Non-metallic waterstops shall be manufactured from a prime virgin resin; reclaimed material is not acceptable. The compound shall contain plasticizers, stabilizers, and other additives to meet specified requirements. Rubber waterstops shall conform to COE CRD-C 513. Polyvinylchloride waterstops shall conform to COE CRD-C 572. Thermoplastic elastomeric rubber waterstops shall conform to ASTM D 471.

### 2.4.2 Non-Metallic Hydrophilic

Swellable strip type compound of polymer modified chloroprene rubber that swells upon contact with water shall conform to ASTM D 412 as follows: Tensile strength 2.9 MPa minimum; ultimate elongation 600 percent minimum. Hardness shall be 50 minimum on the type A durometer and the volumetric expansion ratio in distilled water at 20 degrees C shall be 3 to 1 minimum.

### 2.4.3 Preformed Elastic Adhesive

Preformed plastic adhesive waterstops shall be produced from blends of refined hydrocarbon resins and plasticizing compounds reinforced with inert mineral filler, and shall contain no solvents, asbestos, irritating fumes or

obnoxious odors. The compound shall not depend on oxidizing, evaporating, or chemical action for its adhesive or cohesive strength.

#### 2.4.3.1 Chemical Composition

The chemical composition of the sealing compound shall meet the requirements shown below.

COMPONENT	TEST	PERCENT BY WEIGHT	
		MIN.	MAX.
Bitumen (Hydrocarbon plastic)	ASTM D 4	50	70
Inert Mineral Filler	AASHTO T 111	30	50
Volatile Matter	ASTM D 6	--	2

#### 2.4.3.2 Adhesion Under Hydrostatic Pressure

The sealing compound shall not leak at the joints for a period of 24 hours under a vertical 2 m head pressure. In a separate test, the sealing compound shall not leak under a horizontal pressure of 65 kPa which is reached by slowly applying increments of 13 kPa every minute.

#### 2.4.3.3 Sag of Flow Resistance

No sagging shall be detected when tested as follows: Fill a wooden form 25 mm wide and 150 mm long flush with sealing compound and place in an oven at 58 degrees C in a vertical position for 5 days.

#### 2.4.3.4 Chemical Resistance

The sealing compound when immersed separately in a 5% solution of caustic potash, a 5% solution of hydrochloric acid, 5% solution of sulfuric acid and a saturated hydrogen sulfide solution for 30 days at ambient room temperature shall show no visible deterioration.

### 3 EXECUTION

#### 3.1 JOINTS

Joints shall be installed at locations indicated and as authorized.

##### 3.1.1 Contraction Joints

Contraction joints may be constructed by inserting tempered hardboard strips or rigid PVC or HIPS insert strips into the plastic concrete using a steel parting bar, when necessary, or by cutting the concrete with a saw after concrete has set. Joints shall be approximately 3 mm wide and shall extend into the slab one-fourth the slab thickness, minimum, but not less than 25 mm.

##### 3.1.1.1 Joint Strips

Strips shall be of the required dimensions and as long as practicable. After the first floating, the concrete shall be grooved with a tool at the joint locations. The strips shall be inserted in the groove and depressed until the top edge of the vertical surface is flush with the surface of the slab. The slab shall be floated and finished as specified. Working of the

concrete adjacent to the joint shall be the minimum necessary to fill voids and consolidate the concrete. Where indicated, the top portion of the strip shall be sawed out after the curing period to form a recess for sealer. The removable section of PVC or HIPS strips shall be discarded and the insert left in place. Means shall be provided to insure true alignment of the strips is maintained during insertion.

#### 3.1.1.2 Sawed Joints

Joint sawing shall be early enough to prevent uncontrolled cracking in the slab, but late enough that this can be accomplished without appreciable spalling. Concrete sawing machines shall be adequate in number and power, and with sufficient replacement blades to complete the sawing at the required rate. Joints shall be cut to true alignment and shall be cut in sequence of concrete placement. Sludge and cutting debris shall be removed.

#### 3.1.2 Expansion Joints

Preformed expansion joint filler shall be used in expansion and isolation joints in slabs around columns and between slabs on grade and vertical surfaces where indicated. The filler shall extend the full slab depth, unless otherwise indicated. The edges of the joint shall be neatly finished with an edging tool of 3 mm radius, except where a resilient floor surface will be applied. Where the joint is to receive a sealant, the filler strips shall be installed at the proper level below the finished floor with a slightly tapered, dressed and oiled wood strip temporarily secured to the top thereof to form a recess to the size shown on the drawings. The wood strip shall be removed after the concrete has set. Contractor may opt to use a removable expansion filler cap designed and fabricated for this purpose in lieu of the wood strip. The groove shall be thoroughly cleaned of laitance, curing compound, foreign materials, protrusions of hardened concrete, and any dust which shall be blown out of the groove with oil-free compressed air.

#### 3.1.3 Joint Sealant

Sawed contraction joints and expansion joints in slabs shall be filled with joint sealant, unless otherwise shown. Joint surfaces shall be clean, dry, and free of oil or other foreign material which would adversely affect the bond between sealant and concrete. Joint sealant shall be applied as recommended by the manufacturer of the sealant.

##### 3.1.3.1 Joints With Preformed Compression Seals

Compression seals shall be installed with equipment capable of installing joint seals to the prescribed depth without cutting, nicking, twisting, or otherwise distorting or damaging the seal or concrete and with no more than 5 percent stretching of the seal. The sides of the joint and, if necessary, the sides of the compression seal shall be covered with a coating of lubricant. Butt joints shall be coated with liberal applications of lubricant.

##### 3.1.3.2 Joints With Field-Molded Sealant

Joints shall not be sealed when the sealant material, ambient air, or concrete temperature is less than 4 degrees C. When the sealants are meant to reduce the sound transmission characteristics of interior walls,

ceilings, and floors the guidance provided in ASTM C 919 shall be followed. Joints requiring a bond breaker shall be coated with curing compound or with bituminous paint. Bond breaker and back-up material shall be installed where required. Joints shall be primed and filled flush with joint sealant in accordance with the manufacturer's recommendations.

### 3.2 WATERSTOPS, INSTALLATION AND SPLICES

Waterstops shall be installed at the locations shown to form a continuous water-tight diaphragm. Adequate provision shall be made to support and completely protect the waterstops during the progress of the work. Any waterstop punctured or damaged shall be repaired or replaced. Exposed waterstops shall be protected during application of form release agents to avoid being coated. Suitable guards shall be provided to protect exposed projecting edges and ends of partially embedded waterstops from damage when concrete placement has been discontinued. Splices shall be made by certified trained personnel using approved equipment and procedures.

#### 3.2.1 Non-Metallic

Fittings shall be shop made using a machine specifically designed to mechanically weld the waterstop. A miter guide, proper fixturing (profile dependant), and portable power saw shall be used to miter cut the ends to be joined to ensure good alignment and contact between joined surfaces. The splicing of straight lengths shall be done by squaring the ends to be joined. Continuity of the characteristic features of the cross section of the waterstop (ribs, tabular center axis, protrusions, etc.) shall be maintained across the splice.

##### 3.2.1.1 Rubber Waterstop

Spllices shall be vulcanized or shall be made using cold bond adhesive as recommended by the manufacturer. Spllices for TPE-R shall be as specified for PVC.

##### 3.2.1.2 Polyvinyl Chloride Waterstop

Spllices shall be made by heat sealing the adjacent waterstop edges together using a thermoplastic splicing iron utilizing a non-stick surface specifically designed for waterstop welding. The correct temperature shall be used to sufficiently melt without charring the plastic. The spliced area, when cooled, shall show no signs of separation, holes, or other imperfections when bent by hand in as sharp an angle as possible.

##### 3.2.1.3 Quality Assurance

Edge welding will not be permitted. Centerbulbs shall be compressed or closed when welding to non-centerbulb type. Waterstop splicing defects which are unacceptable include, but are not limited to the following: 1) Tensile strength less than 80 percent of parent section. 2) Free lap joints. 3) Misalignment of centerbulb, ribs, and end bulbs greater than 2 mm. 4) Misalignment which reduces waterstop cross section more than 15 percent. 5) Bond failure at joint deeper than 2 mm or 15 percent of material thickness. 6) Misalignment of waterstop splice resulting in misalignment of waterstop in excess of 13 mm in 3 m. 7) Visible porosity in the weld area, including pin holes. 8) Charred or burnt material. 9)

Bubbles or inadequate bonding. 10) Visible signs of splice separation when cooled splice is bent by hand at a sharp angle.

### 3.2.2 Non-Metallic Hydrophilic Waterstop Installation

Ends to be joined shall be miter cut with sharp knife or shears. The ends shall be adhered with cyanacrylate (super glue) adhesive. When joining hydrophilic type waterstop to PVC waterstop, the hydrophilic waterstop shall be positioned as shown on the drawings. A liberal amount of a single component hydrophilic sealant shall be applied to the junction to complete the transition.

### 3.2.3 Preformed Plastic Adhesive Installation

The installation of preformed plastic adhesive waterstops shall be a prime, peel, place and pour procedure. Joint surfaces shall be clean and dry before priming and just prior to placing the sealing strips. The end of each strip shall be spliced to the next strip with a 25 mm overlap; the overlap shall be pressed firmly to release trapped air. During damp or cold conditions the joint surface shall be flashed with a safe, direct flame to warm and dry the surface adequately; the sealing strips shall be dipped in warm water to soften the material to achieve maximum bond to the concrete surface.

## 3.3 CONSTRUCTION JOINTS

Construction joints are specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE except that construction joints coinciding with expansion and contraction joints shall be treated as expansion or contraction joints as applicable.

## SECTION 03300

## CAST-IN-PLACE STRUCTURAL CONCRETE

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## ACI INTERNATIONAL (ACI)

ACI 117/117R	(1990; Errata) Standard Tolerances for Concrete Construction and Materials
ACI 211.1	(1991) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 211.2	(1991) Standard Practice for Selecting Proportions for Structural Lightweight Concrete
ACI 213R	(1987) Guide for Structural Lightweight Aggregate Concrete
ACI 214.3R	(1988) Simplified Version of the Recommended Practice for Evaluation of Strength Test Results
ACI 301	(1996) Standard Specifications for Structural Concrete
ACI 305R	(1991) Hot Weather Concreting
ACI 318/318R	(1995) Building Code Requirements for Reinforced Concrete and Commentary

## AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 182	(1991) Burlap Cloth Made From Jute or Kenaf
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## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 31	(1991) Making and Curing Concrete Test Specimens in the Field
ASTM C 33	(1993) Concrete Aggregates
ASTM C 39	(1994) Compressive Strength of Cylindrical Concrete Specimens
ASTM C 42	(1994) Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

ASTM C 78	(1994) Flexural Strength of Concrete (Using Simple Beam With Third-Point Loading)
ASTM C 94	(1996) Ready-Mixed Concrete
ASTM C 131	(1989) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1995a) Sieve Analysis of Fine and Coarse Aggregates
ASTM C 143	(1990a) Slump of Hydraulic Cement Concrete
ASTM C 150	(1995) Portland Cement
ASTM C 171	(1995) Sheet Materials for Curing Concrete
ASTM C 172	(1990) Sampling Freshly Mixed Concrete
ASTM C 173	(1994a) Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C 192	(1990a) Making and Curing Concrete Test Specimens in the Laboratory
ASTM C 231	(1991b) Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 260	(1995) Air-Entraining Admixtures for Concrete
ASTM C 309	(1995) Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 330	(1989) Lightweight Aggregates for Structural Concrete
ASTM C 494	(1992) Chemical Admixtures for Concrete
ASTM C 552	(1991) Cellular Glass Thermal Insulation
ASTM C 567	(1991) Unit Weight of Structural Lightweight Concrete
ASTM C 578	(1995) Rigid, Cellular Polystyrene Thermal Insulation
ASTM C 591	(1994) Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM C 595	(1995a) Blended Hydraulic Cements
ASTM C 618	(1996a) Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete



ASTM C 881	(1990) Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C 937	(1980; R 1991) Grout Fluidifier for Preplaced-Aggregate Concrete
ASTM C 940	(1989) Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory
ASTM C 989	(1994a) Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
ASTM C 1017	(1992) Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C 1059	(1991) Latex Agents for Bonding Fresh to Hardened Concrete
ASTM C 1064	(1986; R 1993) Temperature of Freshly Mixed Portland Cement Concrete
ASTM C 1077	(1995a) Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
ASTM C 1107	(1991a) Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM D 75	(1987; R 1992) Sampling Aggregates
ASTM D 1751	(1983; R 1991) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	(1984; R 1992) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM E 96	(1995) Water Vapor Transmission of Materials

## CORPS OF ENGINEERS (COE)

COE CRD-C 94	(1995) Surface Retarders
COE CRD-C 400	(1963) Requirements for Water for Use in Mixing or Curing Concrete
COE CRD-C 521	(1981) Standard Test Method for Frequency and Amplitude of Vibrators for Concrete
COE CRD-C 540	(1971; R 1981) Standard Specification for Nonbituminous Inserts for Contraction Joints in Portland Cement Concrete Airfield Pavements, Sawable Type

COE CRD-C 572 (1974) Corps of Engineers Specifications for Polyvinylchloride Waterstop

NATIONAL READY-MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA TMMB-01 (1992) Truck Mixer Agitator and Front Discharge Concrete Carrier Standards of the Truck Mixer Manufacturers Bureau

NRMCA CPMB 100 (1990) Concrete Plant Standards

NRMCA QC 3 (1984) Quality Control Manual: Section 3, Plant Certifications Checklist: Certification of Ready Mixed Concrete Production Facilities

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

### SD-08 Statements

Mixture Proportions; GA.

The results of trial mixture design studies along with a statement giving the maximum nominal coarse aggregate size and the proportions of ingredients that will be used in the manufacture of each strength or class of concrete, at least 14 days prior to commencing concrete placing operations. Aggregate weights shall be based on the saturated surface dry condition. The statement shall be accompanied by test results from an approved independent commercial testing laboratory, showing that mixture design studies have been made with materials proposed for the project and that the proportions selected will produce concrete of the qualities indicated. No substitutions shall be made in the materials used in the mixture design studies without additional tests to show that the quality of the concrete is satisfactory.

Lightweight Aggregate Concrete; FIO.

Written recommendations from lightweight aggregate supplier on batching and mixing cycles.

### SD-09 Reports

Testing and Inspection for Contractor Quality Control; GA.

Certified copies of laboratory test reports, including mill tests and all other test data, for portland cement, blended cement, pozzolan, ground granulated blast furnace slag, silica fume, aggregate, admixtures, and curing compound proposed for use on this project.

### SD-13 Certificates

Qualifications; GA.

Written documentation for Contractor Quality Control personnel.

### 1.3 QUALIFICATIONS

Contractor Quality Control personnel assigned to concrete construction shall be American Concrete Institute (ACI) Certified Workmen in one of the following grades or shall have written evidence of having completed similar qualification programs:

Concrete Field Testing Technician, Grade I  
Concrete Laboratory Testing Technician, Grade I or II  
Concrete Construction Inspector, Level II

The foreman or lead journeyman of the flatwork finishing crew shall have similar qualification for ACI Concrete Flatwork Technician/Finisher or equal, with written documentation.

### 1.4 SPECIAL REQUIREMENTS

Precast and precast prestressed concrete members shall be designed and constructed in accordance with Sections 03410 PLANT-PRECAST STRUCTURAL CONCRETE and 03412 PLANT-PRECAST PRESTRESSED STRUCTURAL CONCRETE. A pre-installation meeting with the Contracting Officer will be required at least 10 days prior to start of construction on all precast concrete items (excluding void retainers). The Contractor shall be responsible for calling the meeting; the Project Superintendent and active installation personnel shall be present.

### 1.5 GENERAL REQUIREMENTS

#### 1.5.1 Tolerances

Except as otherwise specified herein, tolerances for concrete batching, mixture properties, and construction as well as definition of terms and application practices shall be in accordance with ACI 117/117R. Level and grade tolerance measurements of slabs shall be made as soon as possible after finishing; when forms or shoring are used, the measurements shall be made prior to removal.

##### 1.5.1.1 Floors

For the purpose of this Section the following terminology correlation between ACI 117/117R and this Section shall apply:

Floor Profile Quality Classification From ACI 117/117R	This Section
-----	-----
Conventional Bullfloated	Same
Conventional Straightedged	Same
Flat	Float Finish or Trowel Finish

Levelness tolerance shall not apply where design requires floors to be sloped to drains or sloped for other reasons.

#### 1.5.1.2 Floors by the Straightedge System

The flatness of the floors shall be carefully controlled and the tolerances shall be measured by the straightedge system as specified in paragraph 4.5.7 of ACI 117/117R, using a 3 m straightedge, within 72 hours after floor slab installation and before shores and/or forms are removed. The tolerances shall be met at any and every location at which the straightedge can be placed.

#### 1.5.2 Strength Requirements and w/c Ratio

##### 1.5.2.1 Strength Requirements

Specified compressive strength ( $f'_c$ ) shall be as follows:

COMPRESSIVE STRENGTH	STRUCTURE OR PORTION OF STRUCTURE
35 MPa at 28 days	Precast Member Toppings
30 MPa at 28 days	Concrete Pavement for Vehicular Traffic
28 MPa at 28 days	Grade Beams, Slabs, Cast in Place Walls, Toppings, Piers, and Miscellaneous Concrete

Concrete slabs on-grade shall have a 28-day flexural strength of 4.5 MPa. Concrete made with high-early strength cement shall have a 7-day strength equal to the specified 28-day strength for concrete made with Type I or II portland cement. Compressive strength shall be determined in accordance with ASTM C 39. Flexural strength shall be determined in accordance with ASTM C 78.

- a. Evaluation of Concrete Compressive Strength. Compressive strength specimens (152 by 305 mm cylinders) shall be fabricated by the Contractor and laboratory cured in accordance with ASTM C 31 and tested in accordance with ASTM C 39. The strength of the concrete will be considered satisfactory so long as the average of all sets of three consecutive test results equals or exceeds the specified compressive strength  $f'_c$  and no individual test result falls below the specified strength  $f'_c$  by more than 3.5 MPa. A "test" is defined as the average of two companion cylinders, or if only one cylinder is tested, the results of the single cylinder test. Additional analysis or testing, including taking cores and/or load tests may be required at the Contractor's expense when the strength of the concrete in the structure is considered potentially deficient.
- b. Investigation of Low-Strength Compressive Test Results. When any strength test of standard-cured test cylinders falls below the specified strength requirement by more than 3.5 MPa or if tests of field-cured cylinders indicate deficiencies in protection and curing, steps shall be taken to assure that the load-carrying capacity of the structure is not jeopardized. When the strength of concrete in place is considered potentially deficient, cores shall be obtained and tested in accordance with ASTM C 42. At least three representative cores shall be taken from each member or area of concrete in place that is considered potentially deficient. The location of cores will be determined by the Contracting Officer to

least impair the strength of the structure. Concrete in the area represented by the core testing will be considered adequate if the average strength of the cores is equal to at least 85 percent of the specified strength requirement and if no single core is less than 75 percent of the specified strength requirement. Non-destructive tests (tests other than test cylinders or cores) shall not be used as a basis for acceptance or rejection. The Contractor shall perform the coring and repair the holes. Cores will be tested by the Government.

- c. Load Tests. If the core tests are inconclusive or impractical to obtain or if structural analysis does not confirm the safety of the structure, load tests may be directed by the Contracting Officer in accordance with the requirements of ACI 318/318R. Concrete work evaluated by structural analysis or by results of a load test as being understrength shall be corrected in a manner satisfactory to the Contracting Officer. All investigations, testing, load tests, and correction of deficiencies shall be performed by and at the expense of the Contractor and must be approved by the Contracting Officer, except that if all concrete is found to be in compliance with the drawings and specifications, the cost of investigations, testing, and load tests will be at the expense of the Government.
- d. Evaluation of Concrete Flexural Strength. Flexural strength specimens (beams) shall be fabricated by the Contractor and laboratory cured in accordance with ASTM C 31 and tested in accordance with ASTM C 78. The strength of the concrete will be considered satisfactory so long as the average of all sets of three consecutive test results equals or exceeds the specified flexural strength and no individual test result falls below the specified flexural strength by more than 350 kPa. A "test" is defined as the average of two companion beams. Additional analysis or testing, including taking cores and/or load tests may be required at the Contractor's expense when the strength of the concrete in the slab is considered potentially deficient.

#### 1.5.2.2 Water-Cement Ratio

Maximum water-cement ratio (w/c) for normal weight concrete shall be as follows:

WATER-CEMENT RATIO, BY WEIGHT	STRUCTURE OR PORTION OF STRUCTURE
0.48	All cast in place concrete

These w/c's may cause higher strengths than that required above for compressive or flexural strength. The maximum w/c required will be the equivalent w/c as determined by conversion from the weight ratio of water to cement plus pozzolan, silica fume, and ground granulated blast furnace slag (GGBF slag) by the weight equivalency method as described in ACI 211.1. In the case where silica fume or GGBF slag is used, the weight of the silica fume and GGBF slag shall be included in the equations of ACI 211.1 for the term P which is used to denote the weight of pozzolan.

### 1.5.3 Air Entrainment

Except as otherwise specified for lightweight concrete, all normal weight concrete shall be air entrained to contain between 4 and 7 percent total air, except that when the nominal maximum size coarse aggregate is 19 mm or smaller it shall be between 4.5 and 7.5 percent. Concrete with specified strength over 35 MPa may have 1.0 percent less air than specified above. Specified air content shall be attained at point of placement into the forms. Air content for normal weight concrete shall be determined in accordance with ASTM C 231. Lightweight concrete in parts of the structure shall be air-entrained with a total air content of 4.5 to 7.5 percent, except that if the nominal maximum size coarse aggregate is 9.5 mm or less, the air content shall be 5.5 to 8.5 percent. Air content for lightweight concrete shall be determined in accordance with ASTM C 173.

### 1.5.4 Slump

Slump of the concrete, as delivered to the point of placement into the forms, shall be within the following limits. Slump shall be determined in accordance with ASTM C 143.

Structural Element	Slump	
	Minimum	Maximum
Piers	150 mm	190 mm
Walls, columns and beams	50 mm	100 mm
Foundation walls, substructure walls, footings, slabs	25 mm	75 mm
Any structural concrete approved for placement by pumping:		
At pump	50 mm	150 mm
At discharge of line	25 mm	100 mm

When use of a plasticizing admixture conforming to ASTM C 1017 or when a Type F or G high range water reducing admixture conforming to ASTM C 494 is permitted to increase the slump of concrete, concrete shall have a slump of 50 to 100 mm before the admixture is added and a maximum slump of 200 mm at the point of delivery after the admixture is added. For troweled floors, slump of structural lightweight concrete with normal weight sand placed by pump shall not exceed 125 mm at the point of placement. For other slabs, slump of lightweight concrete shall not exceed 100 mm at point of placement.

### 1.5.5 Concrete Temperature

The temperature of the concrete as delivered shall not exceed 32 degrees C. When the ambient temperature during placing is 5 degrees C or less, or is expected to be at any time within 6 hours after placing, the temperature of the concrete as delivered shall be between 12 and 25 degrees C.

#### 1.5.6 Size of Coarse Aggregate

The largest feasible nominal maximum size aggregate (NMSA) specified in paragraph AGGREGATES shall be used in each placement. However, nominal maximum size of aggregate shall not exceed any of the following: three-fourths of the minimum cover for reinforcing bars, three-fourths of the minimum clear spacing between reinforcing bars, one-fifth of the narrowest dimension between sides of forms, or one-third of the thickness of slabs or toppings.

#### 1.5.7 Special Properties and Products

Concrete may contain admixtures other than air entraining agents, such as water reducers, superplasticizers, or set retarding agents to provide special properties to the concrete, if specified or approved. Any of these materials to be used on the project shall be used in the mix design studies.

#### 1.5.8 Lightweight Aggregate Structural Concrete

Lightweight aggregate structural concrete shall conform to the requirements specified for normal weight concrete except as specified herein. Specified compressive strength shall be at least 28 Mpa at 28 days for cast in place items and 35 Mpa at 28 days for precast items, as determined by test specimens that have been air dried at 50 percent relative humidity for the last 21 days. Air-dry unit weight shall be not over 50 kg at 28 days as determined by ASTM C 567. However, fresh unit weight shall be used for acceptance during concreting, using a correlation factor between the two types of unit weight as determined during mixture design studies. Lightweight aggregate structural concrete floor fill shall have a 28-day compressive strength of at least 17.3 MPa and an air-dry unit weight not exceeding 1850 kg/cubic meter.

### 1.6 MIXTURE PROPORTIONS

Concrete shall be composed of portland cement, other cementitious and pozzolanic materials as specified, aggregates, water and admixtures as specified.

#### 1.6.1 Proportioning Studies for Normal Weight Concrete

Trial design batches, mixture proportioning studies, and testing requirements for various classes and types of concrete specified shall be the responsibility of the Contractor. Except as specified for flexural strength concrete, mixture proportions shall be based on compressive strength as determined by test specimens fabricated in accordance with ASTM C 192 and tested in accordance with ASTM C 39. Samples of all materials used in mixture proportioning studies shall be representative of those proposed for use in the project and shall be accompanied by the manufacturer's or producer's test reports indicating compliance with these specifications. Trial mixtures having proportions, consistencies, and air content suitable for the work shall be made based on methodology described in ACI 211.1, using at least three different water-cement ratios for each type of mixture, which will produce a range of strength encompassing those required for each class and type of concrete required on the project. The maximum water-cement ratios required in the paragraph Maximum Allowable w/c Ratio will be the equivalent water-cement ratio as determined by conversion from the weight ratio of water to cement plus pozzolan, silica fume, and

ground granulated blast furnace slag (GGBF slag) by the weight equivalency method as described in ACI 211.1. In the case where silica fume or GGBF slag is used, the weight of the silica fume and GGBF slag shall be included in the equations in ACI 211.1 for the term P, which is used to denote the weight of pozzolan. If pozzolan is used in the concrete mixture, the minimum pozzolan content shall be 15 percent by weight of the total cementitious material, and the maximum shall be 35 percent. Laboratory trial mixtures shall be designed for maximum permitted slump and air content. Separate sets of trial mixture studies shall be made for each combination of cementitious materials and each combination of admixtures proposed for use. No combination of either shall be used until proven by such studies, except that, if approved in writing and otherwise permitted by these specifications, an accelerator or a retarder may be used without separate trial mixture study. Separate trial mixture studies shall also be made for concrete for any conveying or placing method proposed which requires special properties and for concrete to be placed in unusually difficult placing locations. The temperature of concrete in each trial batch shall be reported. For each water-cement ratio, at least three test cylinders for each test age shall be made and cured in accordance with ASTM C 192. They shall be tested at 7 and 28 days in accordance with ASTM C 39. From these test results, a curve shall be plotted showing the relationship between water-cement ratio and strength for each set of trial mix studies. In addition, a curve shall be plotted showing the relationship between 7 day and 28 day strengths. Each mixture shall be designed to promote easy and suitable concrete placement, consolidation and finishing, and to prevent segregation and excessive bleeding.

#### 1.6.2 Proportioning Studies for Flexural Strength Concrete

Trial design batches, mixture proportioning studies, and testing requirements shall conform to the requirements specified in paragraph Proportioning Studies for Normal Weight Concrete, except that proportions shall be based on flexural strength as determined by test specimens (beams) fabricated in accordance with ASTM C 192 and tested in accordance with ASTM C 78. Procedures given in ACI 211.1 shall be modified as necessary to accommodate flexural strength.

#### 1.6.3 Proportioning Studies for Lightweight Aggregate Structural Concrete

Trial design batches, mixture proportioning studies, and testing requirements shall conform to the requirements specified in paragraph Proportioning Studies for Normal Weight Concrete, except as follows. Trial mixtures having proportions, consistencies and air content suitable for the work shall be made based on methodology described in ACI 211.2, using at least three different cement contents. Trial mixes shall be proportioned to produce air dry unit weight and concrete strengths specified in paragraph GENERAL REQUIREMENTS. Trial mixtures shall be proportioned for maximum permitted slump and air content. Test specimens and testing shall be as specified for normal weight concrete except that 28-day compressive strength shall be determined from test cylinders that have been air dried at 50 percent relative humidity for the last 21 days. Air dry unit weight shall be determined in accordance with ASTM C 567 and shall be designed to be at least 32 kg per cubic meter less than the maximum specified air dry unit weight in paragraph GENERAL REQUIREMENTS. Curves shall be plotted using these results showing the relationship between cement factor and strength and air dry unit weight. Normal weight fine aggregate may be substituted for part or all of the lightweight fine aggregate, provided the concrete



meets the strength and unit weight. A correlation shall also be developed showing the ratio between air dry unit weight and fresh concrete unit weight for each mix.

#### 1.6.4 Average Compressive Strength Required for Mixtures

The mixture proportions selected during mixture design studies shall produce a required average compressive strength ( $f'_{cr}$ ) exceeding the specified compressive strength ( $f'_c$ ) by the amount indicated below. This required average compressive strength,  $f'_{cr}$ , will not be a required acceptance criteria during concrete production. However, whenever the daily average compressive strength at 28 days drops below  $f'_{cr}$  during concrete production, or daily average 7-day strength drops below a strength correlated with the 28-day  $f'_{cr}$ , the mixture shall be adjusted, as approved, to bring the daily average back up to  $f'_{cr}$ . During production, the required  $f'_{cr}$  shall be adjusted, as appropriate, based on the standard deviation being attained on the job.

##### 1.6.4.1 Computations from Test Records

Where a concrete production facility has test records, a standard deviation shall be established in accordance with the applicable provisions of ACI 214.3R. Test records from which a standard deviation is calculated shall represent materials, quality control procedures, and conditions similar to those expected; shall represent concrete produced to meet a specified strength or strengths ( $f'_c$ ) within 7 MPa of that specified for proposed work; and shall consist of at least 30 consecutive tests. A strength test shall be the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days. Required average compressive strength  $f'_{cr}$  used as the basis for selection of concrete proportions shall be the larger of the equations that follow using the standard deviation as determined above:

$$f'_{cr} = f'_c + 1.34S \text{ where units are in MPa}$$

$$f'_{cr} = f'_c + 2.33S - 3.45 \text{ where units are in MPa}$$

Where  $S$  = standard deviation

Where a concrete production facility does not have test records meeting the requirements above but does have a record based on 15 to 29 consecutive tests, a standard deviation shall be established as the product of the calculated standard deviation and a modification factor from the following table:

NUMBER OF TESTS	MODIFICATION FACTOR FOR STANDARD DEVIATION
15	1.16
20	1.08
25	1.03
30 or more	1.00

#### 1.6.4.2 Computations without Previous Test Records

When a concrete production facility does not have sufficient field strength test records for calculation of the standard deviation, the required average strength  $f'_{cr}$  shall be determined as follows:

- a. If the specified compressive strength  $f'_c$  is less than 20 MPa,

$$f'_{cr} = f'_c + 6.9 \text{ MPa}$$

- b. If the specified compressive strength  $f'_c$  is 20 to 35 MPa,

$$f'_{cr} = f'_c + 8.3 \text{ MPa}$$

- c. If the specified compressive strength  $f'_c$  is over 35 MPa,

$$f'_{cr} = f'_c + 9.7 \text{ MPa}$$

#### 1.6.5 Average Flexural Strength Required for Mixtures

The mixture proportions selected during mixture design studies for flexural strength mixtures and the mixture used during concrete production shall be designed and adjusted during concrete production as approved, except that the overdesign for average flexural strength shall simply be 15 percent greater than the specified flexural strength at all times.

#### 1.7 STORAGE OF MATERIALS

Cement and other cementitious materials shall be stored in weathertight buildings, bins, or silos which will exclude moisture and contaminants and keep each material completely separated. Aggregate stockpiles shall be arranged and used in a manner to avoid excessive segregation and to prevent contamination with other materials or with other sizes of aggregates. Aggregate shall not be stored directly on ground unless a sacrificial layer is left undisturbed. Reinforcing bars and accessories shall be stored above the ground on platforms, skids or other supports. Other materials shall be stored in such a manner as to avoid contamination and deterioration. Admixtures which have been in storage at the project site for longer than 6 months or which have been subjected to freezing shall not be used unless retested and proven to meet the specified requirements. Materials shall be capable of being accurately identified after bundles or containers are opened.

#### 1.8 GOVERNMENT ASSURANCE INSPECTION AND TESTING

Day-to day inspection and testing shall be the responsibility of the Contractor Quality Control (CQC) staff. However, representatives of the Contracting Officer can and will inspect construction as considered appropriate and will monitor operations of the Contractor's CQC staff. Government inspection or testing will not relieve the Contractor of any of his CQC responsibilities.

### 1.8.1 Materials

The Government will sample and test aggregates, cementitious materials, other materials, and concrete to determine compliance with the specifications as considered appropriate. The Contractor shall provide facilities and labor as may be necessary for procurement of representative test samples. Samples of aggregates will be obtained at the point of batching in accordance with ASTM D 75. Other materials will be sampled from storage at the jobsite or from other locations as considered appropriate. Samples may be placed in storage for later testing when appropriate.

### 1.8.2 Fresh Concrete

Fresh concrete will be sampled as delivered in accordance with ASTM C 172 and tested in accordance with these specifications, as considered necessary.

### 1.8.3 Hardened Concrete

Tests on hardened concrete will be performed by the Government when such tests are considered necessary.

### 1.8.4 Inspection

Concrete operations may be tested and inspected by the Government as the project progresses. Failure to detect defective work or material will not prevent rejection later when a defect is discovered nor will it obligate the Government for final acceptance.

## 2 PRODUCTS

### 2.1 CEMENTITIOUS MATERIALS

Cementitious Materials shall be portland cement, portland-pozzolan cement, portland blast-furnace slag cement, or portland cement in combination with pozzolan or ground granulated blast furnace slag and shall conform to appropriate specifications listed below. Use of cementitious materials in concrete which will have surfaces exposed in the completed structure shall be restricted so there is no change in color, source, or type of cementitious material.

#### 2.1.1 Portland Cement

ASTM C 150, Type I with a maximum 15 percent amount of tricalcium aluminate, or Type II.

#### 2.1.2 High-Early-Strength Portland Cement

ASTM C 150, Type III with tricalcium aluminate limited to 5 percent, low alkali. Type III cement shall be used only in isolated instances and only when approved in writing.

#### 2.1.3 Blended Cements

ASTM C 595, Type IP.

#### 2.1.4 Pozzolan (Fly Ash)

ASTM C 618, Class F with the optional requirements for multiple factor, drying shrinkage, and uniformity from Table 2A of ASTM C 618. If pozzolan is used, it shall never be less than 15 percent nor more than 35 percent by weight of the total cementitious material.

#### 2.1.5 Ground Granulated Blast-Furnace (GGBF) Slag

ASTM C 989, Grade 120.

### 2.2 AGGREGATES

Aggregates shall conform to the following.

#### 2.2.1 Fine Aggregate

Fine aggregate shall conform to the quality and gradation requirements of ASTM C 33.

#### 2.2.2 Coarse Aggregate

Coarse aggregate shall conform to ASTM C 33, Class 5S,

#### 2.2.3 Lightweight Aggregate

Lightweight fine and coarse aggregate shall conform to the quality and gradation requirements of ASTM C 330, for coarse aggregate. Lightweight aggregate shall be prewetted in accordance with the Manufacturer's instructions unless otherwise specified. For pumped concrete, prewetting shall be sufficient to ensure that slump loss through the pump line does not exceed 100 mm.

### 2.3 CHEMICAL ADMIXTURES

Chemical admixtures, when required or permitted, shall conform to the appropriate specification listed. Admixtures shall be furnished in liquid form and of suitable concentration for easy, accurate control of dispensing.

#### 2.3.1 Air-Entraining Admixture

ASTM C 260 and shall consistently entrain the air content in the specified ranges under field conditions.

#### 2.3.2 Accelerating Admixture

ASTM C 494, Type C or E, except that calcium chloride or admixtures containing calcium chloride shall not be used.

#### 2.3.3 Water-Reducing or Retarding Admixture

ASTM C 494, Type A, B, or D, except that the 6-month and 1-year compressive and flexural strength tests are waived.

#### 2.3.4 High-Range Water Reducer

ASTM C 494, Type F or G, except that the 6-month and 1-year strength requirements are waived. The admixture shall be used only when approved in writing, such approval being contingent upon particular mixture control as described in the Contractor's Quality Control Plan and upon performance of separate mixture design studies.

#### 2.3.5 Surface Retarder

COE CRD-C 94.

#### 2.3.6 Expanding Admixture

Aluminum powder type expanding admixture conforming to ASTM C 937.

#### 2.3.7 Other Chemical Admixtures

Chemical admixtures for use in producing flowing concrete shall comply with ASTM C 1017, Type I or II. These admixtures shall be used only when approved in writing, such approval being contingent upon particular mixture control as described in the Contractor's Quality Control Plan and upon performance of separate mixture design studies.

### 2.4 CURING MATERIALS

#### 2.4.1 Impervious-Sheet

Impervious-sheet materials shall conform to ASTM C 171, type optional, except, that polyethylene sheet shall not be used.

#### 2.4.2 Membrane-Forming Compound

Membrane-Forming curing compound shall conform to ASTM C 309, Type 1-D or 2, except that only a styrene acrylate or chlorinated rubber compound meeting Class B requirements shall be used for surfaces that are to be painted or are to receive bituminous roofing, or waterproofing, or floors that are to receive adhesive applications of resilient flooring. The curing compound selected shall be compatible with any subsequent paint, roofing, waterproofing, or flooring specified. Nonpigmented compound shall contain a fugitive dye, and shall have the reflective requirements in ASTM C 309 waived.

#### 2.4.3 Burlap and Cotton Mat

Burlap and cotton mat used for curing shall conform to AASHTO M 182.

### 2.5 WATER

Water for mixing and curing shall be fresh, clean, potable, and free of injurious amounts of oil, acid, salt, or alkali, except that non-potable water may be used if it meets the requirements of COE CRD-C 400.

### 2.6 NONSHRINK GROUT

Nonshrink grout shall conform to ASTM C 1107, Grade A, B, and C, and shall be a commercial formulation suitable for the proposed application.

## 2.7 NONSLIP SURFACING MATERIAL

Nonslip surfacing material shall consist of 55 percent, minimum, aluminum oxide or silicon-dioxide abrasive ceramically bonded together to form a homogeneous material sufficiently porous to provide a good bond with portland cement paste; or factory-graded emery aggregate consisting of not less than 45 percent aluminum oxide and 25 percent ferric oxide. The aggregate shall be well graded from particles retained on the 0.6 mm sieve to particles passing the 2.36 mm sieve.

## 2.8 LATEX BONDING AGENT

Latex agents for bonding fresh to hardened concrete shall conform to ASTM C 1059.

## 2.9 EPOXY RESIN

Epoxy resins for use in repairs shall conform to ASTM C 881, Type V, Grade 2. Class as appropriate to the existing ambient and surface temperatures.

## 2.10 EMBEDDED ITEMS

Embedded items shall be of the size and type indicated or as needed for the application. Dovetail slots shall be galvanized steel. Hangers for suspended ceilings shall be as specified in Section 09510 ACOUSTICAL CEILINGS. Inserts for shelf angles and bolt hangers shall be of malleable iron or cast or wrought steel.

## 2.11 FLOOR HARDENER

Floor hardener shall be a colorless aqueous solution containing zinc silicofluoride, magnesium silicofluoride, or sodium silicofluoride. These silicofluorides can be used individually or in combination. Proprietary hardeners may be used if approved in writing by the Contracting Officer.

## 2.12 PERIMETER INSULATION

Perimeter insulation shall be polystyrene conforming to ASTM C 578, Type II; polyurethane conforming to ASTM C 591, Type II; or cellular glass conforming to ASTM C 552, Type I or IV.

## 2.13 VAPOR BARRIER

Vapor barrier shall be polyethylene sheeting with a minimum thickness of 0.15 mm (6 mils) or other equivalent material having a vapor permeance rating not exceeding 30 nanograms per Pascal per second per square meter (0.5 perms) as determined in accordance with ASTM E 96.

## 2.14 JOINT MATERIALS

### 2.14.1 Joint Fillers, Sealers, and Waterstops

Expansion joint fillers shall be preformed materials conforming to ASTM D 1751 or ASTM D 1752 and as specified in Section 03250 EXPANSION JOINTS, CONTRACTION JOINTS, AND WATERSTOPS. Materials for waterstops shall be in accordance with Section 03250 EXPANSION JOINTS, CONTRACTION JOINTS, AND

WATERSTOPS. Materials for and sealing of joints shall conform to the requirements of Section 07920 JOINT SEALING.

#### 2.14.2 Contraction Joints in Slabs

Sawable type contraction joint inserts shall conform to COE CRD-C 540. Nonsawable joint inserts shall have sufficient stiffness to permit placement in plastic concrete without undue deviation from a straight line and shall conform to the physical requirements of COE CRD-C 540, with the exception of Section 3.4 "Resistance to Sawing". Plastic inserts shall be polyvinyl chloride conforming to the materials requirements of COE CRD-C 572.

### 3 EXECUTION

#### 3.1 PREPARATION FOR PLACING

Before commencing concrete placement, the following shall be performed. Surfaces to receive concrete shall be clean and free from frost, ice, mud, and water. Forms shall be in place, cleaned, coated, and adequately supported, in accordance with Section 03100 STRUCTURAL CONCRETE FORMWORK. Reinforcing steel shall be in place, cleaned, tied, and adequately supported, in accordance with Section 03200 CONCRETE REINFORCEMENT. Transporting and conveying equipment shall be in-place, ready for use, clean, and free of hardened concrete and foreign material. Equipment for consolidating concrete shall be at the placing site and in proper working order. Equipment and material for curing and for protecting concrete from weather or mechanical damage shall be at the placing site, in proper working condition and in sufficient amount for the entire placement. When hot, windy conditions during concreting appear probable, equipment and material shall be at the placing site to provide windbreaks, shading, fogging, or other action to prevent plastic shrinkage cracking or other damaging drying of the concrete.

##### 3.1.1 Foundations

###### 3.1.1.1 Concrete on Earth Foundations

Earth (subgrade, base, or subbase courses) surfaces upon which concrete is to be placed shall be clean, damp, and free from debris, frost, ice, and standing or running water. Prior to placement of concrete, the foundation shall be well drained and shall be satisfactorily graded and uniformly compacted.

###### 3.1.1.2 Preparation of Previously Placed Concrete

Concrete surfaces to which other concrete is to be bonded shall be abraded in an approved manner that will expose sound aggregate uniformly without damaging the concrete. Laitance and loose particles shall be removed. Surfaces shall be thoroughly washed and shall be moist but without free water when concrete is placed.

##### 3.1.2 Vapor Barrier

Vapor barrier shall be provided beneath the interior on-grade concrete floor slabs. The greatest widths and lengths practicable shall be used to eliminate joints wherever possible. Joints shall be lapped a minimum of 300 mm. Torn, punctured, or damaged vapor barrier material shall be removed and

new vapor barrier shall be provided prior to placing concrete. For minor repairs, patches may be made using laps of at least 300 mm. Lapped joints shall be sealed and edges patched with pressure-sensitive adhesive or tape not less than 50 mm wide and compatible with the membrane. Vapor barrier shall be placed directly on underlying subgrade, base course, or capillary water barrier, unless it consists of crushed material or large granular material which could puncture the vapor barrier. In this case, the surface shall be choked with a light layer of sand, as approved, before placing the vapor barrier. A 50 mm layer of compacted, clean concrete sand (fine aggregate) shall be placed on top of the vapor barrier before placing concrete. Concrete placement shall be controlled so as to prevent damage to the vapor barrier, or any covering sand.

#### 3.1.3 Perimeter Insulation

Perimeter insulation shall be installed at locations indicated. Adhesive shall be used where insulation is applied to the interior surface of foundation walls and may be used for exterior application.

#### 3.1.4 Embedded Items

Before placement of concrete, care shall be taken to determine that all embedded items are firmly and securely fastened in place as indicated on the drawings, or required. Conduit and other embedded items shall be clean and free of oil and other foreign matter such as loose coatings or rust, paint, and scale. The embedding of wood in concrete will be permitted only when specifically authorized or directed. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable materials to prevent the entry of concrete into voids. Welding shall not be performed on embedded metals within 600 mm of the surface of the concrete. Tack welding shall not be performed on or to embedded items.

### 3.2 CONCRETE PRODUCTION

Batch-type equipment shall be used for producing concrete. Ready-mixed concrete shall be batched, mixed, and transported in accordance with ASTM C 94, except as otherwise specified. Truck mixers, agitators, and nonagitating transporting units shall comply with NRMCA TMMB-01. Ready-mix plant equipment and facilities shall be certified in accordance with NRMCA QC 3. Approved batch tickets shall be furnished for each load of ready-mixed concrete. Site-mixed concrete shall be produced in accordance with ACI 301, and plant shall conform to NRMCA CPMB 100.

### 3.3 LIGHTWEIGHT AGGREGATE CONCRETE

In addition to the requirements specified for normal weight concrete, lightweight aggregate concrete shall conform to the following. The batching and mixing cycle shall be as directed based on written recommendations from the aggregate supplier which the Contractor shall furnish. Unless otherwise directed, the mixer shall be charged with approximately 2/3 of the total mixing water and all of the aggregate. This shall be mixed for at least 1-1/2 minutes in a stationary mixer or 15 revolutions at mixing speed in a truck mixer. The remaining ingredients shall then be added and mixing continued as specified for normal weight concrete. Lightweight aggregate concrete shall not be vibrated to the extent that large particles of aggregate float to the surface. During finishing, lightweight aggregate concrete shall not be worked to the extent that mortar is driven down and



lightweight coarse aggregate appears at the surface. Lightweight aggregate concrete to be pumped shall have a cement content of at least 335 kg per cubic meter. A field trial run of lightweight aggregate concrete placement and finishing shall be made in accordance with ACI 213R.

#### 3.4 TRANSPORTING CONCRETE TO PROJECT SITE

Concrete shall be transported to the placing site in trucks. Nonagitating equipment, other than pumps, shall not be used for transporting lightweight aggregate concrete.

#### 3.5 CONVEYING CONCRETE ON SITE

Concrete shall be conveyed from mixer or transporting unit to forms as rapidly as possible and within the time interval specified by methods which will prevent segregation or loss of ingredients using following equipment. Conveying equipment shall be cleaned before each placement.

##### 3.5.1 Buckets

The interior hopper slope shall be not less than 58 degrees from the horizontal, the minimum dimension of the clear gate opening shall be at least 5 times the nominal maximum-size aggregate, and the area of the gate opening shall not be less than 0.2 square meters. The maximum dimension of the gate opening shall not be greater than twice the minimum dimension. The bucket gates shall be essentially grout tight when closed and may be manually, pneumatically, or hydraulically operated except that buckets larger than 1.5 cubic meters shall not be manually operated. The design of the bucket shall provide means for positive regulation of the amount and rate of deposit of concrete in each dumping position.

##### 3.5.2 Transfer Hoppers

Concrete may be charged into nonagitating hoppers for transfer to other conveying devices. Transfer hoppers shall be capable of receiving concrete directly from delivery vehicles and shall have conical-shaped discharge features. The transfer hopper shall be equipped with a hydraulically operated gate and with a means of external vibration to effect complete discharge. Concrete shall not be held in nonagitating transfer hoppers more than 30 minutes.

##### 3.5.3 Trucks

Truck mixers operating at agitating speed or truck agitators used for transporting plant-mixed concrete shall conform to the requirements of ASTM C 94. Nonagitating equipment shall be used only for transporting plant-mixed concrete over a smooth road and when the hauling time is less than 15 minutes. Bodies of nonagitating equipment shall be smooth, watertight, metal containers specifically designed to transport concrete, shaped with rounded corners to minimize segregation, and equipped with gates that will permit positive control of the discharge of the concrete.

#### 3.5.4 Chutes

When concrete can be placed directly from a truck mixer, agitator, or nonagitating equipment, the chutes normally attached to this equipment by the manufacturer may be used. A discharge deflector shall be used when required by the Contracting Officer. Separate chutes and other similar equipment will not be permitted for conveying concrete.

#### 3.5.5 Belt Conveyors

Belt conveyors shall be designed and operated to assure a uniform flow of concrete from mixer to final place of deposit without segregation of ingredients or loss of mortar and shall be provided with positive means, such as discharge baffle or hopper, for preventing segregation of the concrete at the transfer points and the point of placing. Belt conveyors shall be constructed such that the idler spacing shall not exceed 900 mm. The belt speed shall be a minimum of 90 meters per minute and a maximum of 225 meters per minute. If concrete is to be placed through installed horizontal or sloping reinforcing bars, the conveyor shall discharge concrete into a pipe or elephant truck that is long enough to extend through the reinforcing bars.

#### 3.5.6 Concrete Pumps

Concrete may be conveyed by positive displacement pump when approved. The pumping equipment shall be piston or squeeze pressure type; pneumatic placing equipment shall not be used. The pipeline shall be rigid steel pipe or heavy-duty flexible hose. The inside diameter of the pipe shall be at least 3 times the nominal maximum-size coarse aggregate in the concrete mixture to be pumped but not less than 100 mm. Aluminum pipe shall not be used.

### 3.6 PLACING CONCRETE

Mixed concrete shall be discharged within 1-1/2 hours or before the mixer drum has revolved 300 revolutions, whichever comes first after the introduction of the mixing water to the cement and aggregates. When the concrete temperature exceeds 30 degrees C, the time shall be reduced to 45 minutes. Concrete shall be placed within 15 minutes after it has been discharged from the transporting unit. Concrete shall be handled from mixer or transporting unit to forms in a continuous manner until the approved unit of operation is completed. Adequate scaffolding, ramps and walkways shall be provided so that personnel and equipment are not supported by in-place reinforcement. Placing will not be permitted when the sun, heat, wind, or limitations of facilities furnished by the Contractor prevent proper consolidation, finishing and curing. Sufficient placing capacity shall be provided so that concrete can be kept free of cold joints.

#### 3.6.1 Depositing Concrete

Concrete shall be deposited as close as possible to its final position in the forms, and there shall be no vertical drop greater than 1.5 meters except where suitable equipment is provided to prevent segregation and where specifically authorized. Depositing of the concrete shall be so regulated that it will be effectively consolidated in horizontal layers not more than 300 mm thick, except that all slabs shall be placed in a single layer. Concrete to receive other construction shall be screeded to the proper

level. Concrete shall be deposited continuously in one layer or in layers so that fresh concrete is deposited on in-place concrete that is still plastic. Fresh concrete shall not be deposited on concrete that has hardened sufficiently to cause formation of seams or planes of weakness within the section. Concrete that has surface dried, partially hardened, or contains foreign material shall not be used. When temporary spreaders are used in the forms, the spreaders shall be removed as their service becomes unnecessary. Concrete shall not be placed in slabs over columns and walls until concrete in columns and walls has been in-place at least two hours or until the concrete begins to lose its plasticity. Concrete for beams, girders, brackets, column capitals, haunches, and drop panels shall be placed at the same time as concrete for adjoining slabs.

### 3.6.2 Consolidation

Immediately after placing, each layer of concrete shall be consolidated by internal vibrators, except for slabs 100 mm thick or less. The vibrators shall at all times be adequate in effectiveness and number to properly consolidate the concrete; a spare vibrator shall be kept at the jobsite during all concrete placing operations. The vibrators shall have a frequency of not less than 10,000 vibrations per minute, an amplitude of at least 0.6 mm, and the head diameter shall be appropriate for the structural member and the concrete mixture being placed. Vibrators shall be inserted vertically at uniform spacing over the area of placement. The distance between insertions shall be approximately 1-1/2 times the radius of action of the vibrator so that the area being vibrated will overlap the adjacent just-vibrated area by a reasonable amount. The vibrator shall penetrate rapidly to the bottom of the layer and at least 150 mm into the preceding layer if there is such. Vibrator shall be held stationary until the concrete is consolidated and then vertically withdrawn slowly while operating. Form vibrators shall not be used unless specifically approved and unless forms are constructed to withstand their use. Vibrators shall not be used to move concrete within the forms. Slabs 100 mm and less in thickness shall be consolidated by properly designed vibrating screeds or other approved technique. Excessive vibration of lightweight concrete resulting in segregation or flotation of coarse aggregate shall be prevented. Frequency and amplitude of vibrators shall be determined in accordance with COE CRD-C 521. Grate tampers ("jitterbugs") shall not be used.

### 3.6.3 Cold Weather Requirements

Special protection measures, approved by the Contracting Officer, shall be used if freezing temperatures are anticipated before the expiration of the specified curing period. The ambient temperature of the air where concrete is to be placed and the temperature of surfaces to receive concrete shall be not less than 5 degrees C. The temperature of the concrete when placed shall be not less than 10 degrees C nor more than 25 degrees C. Heating of the mixing water or aggregates will be required to regulate the concrete placing temperature. Materials entering the mixer shall be free from ice, snow, or frozen lumps. Salt, chemicals or other materials shall not be incorporated in the concrete to prevent freezing. Upon written approval, an accelerating admixture conforming to ASTM C 494, Type C or E may be used, provided it contains no calcium chloride. Calcium chloride shall not be used.

#### 3.6.4 Hot Weather Requirements

When the ambient temperature during concrete placing is expected to exceed 30 degrees C, the concrete shall be placed and finished with procedures previously submitted and as specified herein. The concrete temperature at time of delivery to the forms shall not exceed the temperature shown in the table below when measured in accordance with ASTM C 1064. Cooling of the mixing water or aggregates or placing concrete in the cooler part of the day may be required to obtain an adequate placing temperature. A retarder may be used, as approved, to facilitate placing and finishing. Steel forms and reinforcements shall be cooled as approved prior to concrete placement when steel temperatures are greater than 49 degrees C. Conveying and placing equipment shall be cooled if necessary to maintain proper concrete-placing temperature.

##### Maximum Allowable Concrete Placing Temperature

Relative Humidity, Percent, During Time of Concrete Placement	Maximum Allowable Concrete Temperature Degrees
Greater than 60	33 C
40-60	30 C
Less than 40	27 C

#### 3.6.5 Prevention of Plastic Shrinkage Cracking

During hot weather with low humidity, and particularly with appreciable wind, as well as interior placements when space heaters produce low humidity, the Contractor shall be alert to the tendency for plastic shrinkage cracks to develop and shall institute measures to prevent this. Particular care shall be taken if plastic shrinkage cracking is potentially imminent and especially if it has developed during a previous placement. Periods of high potential for plastic shrinkage cracking can be anticipated by use of Fig. 2.1.5 of ACI 305R. In addition the concrete placement shall be further protected by erecting shades and windbreaks and by applying fog sprays of water, sprinkling, ponding or wet covering. Plastic shrinkage cracks that occur shall be filled by injection of epoxy resin as directed, after the concrete hardens. Plastic shrinkage cracks shall never be troweled over or filled with slurry.

#### 3.6.6 Placing Concrete in Congested Areas

Special care shall be used to ensure complete filling of the forms, elimination of all voids, and complete consolidation of the concrete when placing concrete in areas congested with reinforcing bars, embedded items, waterstops and other tight spacing. An appropriate concrete mixture shall be used, and the nominal maximum size of aggregate (NMSA) shall meet the specified criteria when evaluated for the congested area. Vibrators with heads of a size appropriate for the clearances available shall be used, and the consolidation operation shall be closely supervised to ensure complete and thorough consolidation at all points. Where necessary, splices of reinforcing bars shall be alternated to reduce congestion. Where two mats of closely spaced reinforcing are required, the bars in each mat shall be placed in matching alignment to reduce congestion. Reinforcing bars may be

temporarily crowded to one side during concrete placement provided they are returned to exact required location before concrete placement and consolidation are completed.

### 3.6.7 Placing Flowable Concrete

If a plasticizing admixture conforming to ASTM C 1017 is used or if a Type F or G high range water reducing admixture is permitted to increase the slump, the concrete shall meet all requirements of paragraph GENERAL REQUIREMENTS in PART 1. Extreme care shall be used in conveying and placing the concrete to avoid segregation. Consolidation and finishing shall meet all requirements of paragraphs Placing Concrete, Finishing Formed Surfaces, and Finishing Unformed Surfaces. No relaxation of requirements to accommodate flowable concrete will be permitted.

### 3.7 JOINTS

Joints shall be located and constructed as indicated or approved. Joints not indicated on the drawings shall be located and constructed to minimize the impact on the strength of the structure. In general, such joints shall be located near the middle of the spans of supported slabs, beams, and girders unless a beam intersects a girder at this point, in which case the joint in the girder shall be offset a distance equal to twice the width of the beam. Joints in walls and columns shall be at the underside of floors, slabs, beams, or girders and at the tops of footings or floor slabs, unless otherwise approved. Joints shall be perpendicular to the main reinforcement. All reinforcement shall be continued across joints; except that reinforcement or other fixed metal items shall not be continuous through expansion joints, or through construction or contraction joints in slabs on grade. Reinforcement shall be 50 mm clear from each joint. Except where otherwise indicated, construction joints between interior slabs on grade and vertical surfaces shall consist of 1.5 kg per square meter asphalt-saturated felt, extending for the full depth of the slab. The perimeters of the slabs shall be free of fins, rough edges, spalling, or other unsightly appearance. Reservoir for sealant for construction and contraction joints in slabs shall be formed to the dimensions shown on the drawings by removing snap-out joint-forming inserts, by sawing sawable inserts, or by sawing to widen the top portion of sawed joints. Joints to be sealed shall be cleaned and sealed as indicated and in accordance with Section 07920 JOINT SEALING.

#### 3.7.1 Construction Joints

For concrete other than slabs on grade, construction joints shall be located so that the unit of operation does not exceed 18 meters or as detailed and shown on the drawings. Concrete shall be placed continuously so that each unit is monolithic in construction. Fresh concrete shall not be placed against adjacent hardened concrete until it is at least 24 hours old. Construction joints shall be located as indicated or approved. Where concrete work is interrupted by weather, end of work shift or other similar type of delay, location and type of construction joint shall be subject to approval of the Contracting Officer. Unless otherwise indicated and except for slabs on grade, reinforcing steel shall extend through construction joints. Construction joints in slabs on grade shall be keyed or doweled as shown. Concrete columns, walls, or piers shall be in place at least 2 hours, or until the concrete begins to lose its plasticity, before placing concrete for beams, girders, or slabs thereon. In walls having door or

window openings, lifts shall terminate at the top and bottom of the opening. Other lifts shall terminate at such levels as to conform to structural requirements or architectural details. Where horizontal construction joints in walls or columns are required, a strip of 25 mm square-edge lumber, beveled and oiled to facilitate removal, shall be tacked to the inside of the forms at the construction joint. Concrete shall be placed to a point 25 mm above the underside of the strip. The strip shall be removed 1 hour after the concrete has been placed, and any irregularities in the joint line shall be leveled off with a wood float, and all laitance shall be removed. Prior to placing additional concrete, horizontal construction joints shall be prepared as specified in paragraph Previously Placed Concrete.

### 3.7.2 Contraction Joints in Slabs on Grade

Contraction joints shall be located and detailed as shown on the drawings. Contraction joints shall conform to the requirements of Section 03250 EXPANSION JOINTS, CONTRACTION JOINTS, AND WATERSTOPS and Section 07920 JOINT SEALING and as specified herein. Contraction Joints shall be produced by forming a weakened plane in the concrete slab by use of rigid inserts impressed in the concrete during placing operations, use of snap-out plastic joint forming inserts, or sawing a continuous slot with a concrete saw. Regardless of method used to produce the weakened plane, it shall be 1/4 the depth of the slab thickness and between 3 and 5 mm wide. For saw-cut joints, cutting shall be timed properly with the set of the concrete. Cutting shall be started as soon as the concrete has hardened sufficiently to prevent raveling of the edges of the saw cut. Cutting shall be completed before shrinkage stresses become sufficient to produce cracking. Reservoir for joint sealant shall be formed as previously specified.

### 3.7.3 Expansion Joints

Installation of expansion joints and sealing of these joints shall conform to the requirements of Section 03250 EXPANSION JOINTS, CONTRACTION JOINTS, AND WATERSTOPS and Section 07920 JOINT SEALING.

### 3.7.4 Waterstops

Waterstops shall be installed in conformance with the locations and details shown on the drawings using materials and procedures specified in Section 03250 EXPANSION JOINTS, CONTRACTION JOINTS, AND WATERSTOPS.

### 3.7.5 Dowels and Tie Bars

Dowels and tie bars shall be installed at the locations shown on the drawings and to the details shown, using materials and procedures specified in Section 03200 CONCRETE REINFORCEMENT and herein. Conventional smooth "paving" dowels shall be installed in slabs using approved methods to hold the dowel in place during concreting within a maximum alignment tolerance of 1 mm in 100 mm. "Structural" type deformed bar dowels, or tie bars, shall be installed to meet the specified tolerances. Care shall be taken during placing adjacent to and around dowels and tie bars to ensure there is no displacement of the dowel or tie bar and that the concrete completely embeds the dowel or tie bar and is thoroughly consolidated.

### 3.8 FINISHING FORMED SURFACES

Forms, form materials, and form construction are specified in Section 03100 STRUCTURAL CONCRETE FORMWORK. Finishing of formed surfaces shall be as specified herein. Unless another type of architectural or special finish is specified, surfaces shall be left with the texture imparted by the forms except that defective surfaces shall be repaired. Unless painting of surfaces is required, uniform color of the concrete shall be maintained by use of only one mixture without changes in materials or proportions for any structure or portion of structure that requires a Class A or B finish. Except for major defects, as defined hereinafter, surface defects shall be repaired as specified herein within 24 hours after forms are removed. Repairs of the so-called "plaster-type" will not be permitted in any location. Tolerances of formed surfaces shall conform to the requirements of ACI 117/117R. These tolerances apply to the finished concrete surface, not to the forms themselves; forms shall be set true to line and grade. Form tie holes requiring repair and other defects whose depth is at least as great as their surface diameter shall be repaired as specified in paragraph Damp-Pack Mortar Repair. Defects whose surface diameter is greater than their depth shall be repaired as specified in paragraph Repair of Major Defects. Repairs shall be finished flush with adjacent surfaces and with the same surface texture. The cement used for all repairs shall be a blend of job cement with white cement proportioned so that the final color after curing and aging will be the same as the adjacent concrete. Concrete with excessive honeycomb, or other defects which affect the strength of the member, will be rejected. Repairs shall be demonstrated to be acceptable and free from cracks or loose or drummy areas at the completion of the contract and, for Class A and B Finishes, shall be inconspicuous. Repairs not meeting these requirements will be rejected and shall be replaced.

#### 3.8.1 Class B Finish

Class B finish is required for finished concrete surfaces are permanently exposed to public view. Fins, ravelings, and loose material shall be removed, all surface defects over 12 mm in diameter or more than 12 mm deep, shall be repaired and, except as otherwise indicated or as specified in Section 03100 STRUCTURAL CONCRETE FORMWORK, holes left by removal of form ties shall be reamed and filled. Defects more than 12 mm in diameter shall be cut back to sound concrete, but in all cases at least 25 mm deep. The Contractor shall prepare a sample panel for approval (as specified in PART 1) before commencing repair, showing that the surface texture and color match will be attained. Metal tools shall not be used to finish repairs in Class A surfaces.

#### 3.8.2 Class C and Class D Finish

Class C finish is required for exposed surfaces which are not in view to the public (such as mechanical and electrical equipment rooms). Class D finish shall be provided in concealed to view spaces. Fins, ravelings, and loose material shall be removed, and, except as otherwise indicated or as specified in Section 03100 STRUCTURAL CONCRETE FORMWORK, holes left by removal of form ties shall be reamed and filled. Honeycomb and other defects more than 12 mm deep or more than 50 mm in diameter shall be repaired. Defects more than 50 mm in diameter shall be cut back to sound concrete, but in all cases at least 25 mm deep.

### 3.9 REPAIRS

#### 3.9.1 Damp-Pack Mortar Repair

Form tie holes requiring repair and other defects whose depth is at least as great as their surface diameter but not over 100 mm shall be repaired by the damp-pack mortar method. Form tie holes shall be reamed and other similar defects shall be cut out to sound concrete. The void shall then be thoroughly cleaned, thoroughly wetted, brush-coated with a thin coat of neat cement grout and filled with mortar. Mortar shall be a stiff mix of 1 part portland cement to 2 parts fine aggregate passing the 1.18 mm sieve, and minimum amount of water. Only sufficient water shall be used to produce a mortar which, when used, will stick together on being molded into a ball by a slight pressure of the hands and will not exude water but will leave the hands damp. Mortar shall be mixed and allowed to stand for 30 to 45 minutes before use with remixing performed immediately prior to use. Mortar shall be thoroughly tamped in place in thin layers using a hammer and hardwood block. Holes passing entirely through walls shall be completely filled from the inside face by forcing mortar through to the outside face. All holes shall be packed full. Damp-pack repairs shall be moist cured for at least 48 hours.

#### 3.9.2 Repair of Major Defects

Major defects will be considered to be those more than 12 mm deep or, for Class A and B finishes, more than 12 mm in diameter and, for Class C and D finishes, more than 50 mm in diameter. Also included are any defects of any kind whose depth is over 100 mm or whose surface diameter is greater than their depth. Major defects shall be repaired as specified below.

##### 3.9.2.1 Surface Application of Mortar Repair

Defective concrete shall be removed, and removal shall extend into completely sound concrete. Approved equipment and procedures which will not cause cracking or microcracking of the sound concrete shall be used. If reinforcement is encountered, concrete shall be removed so as to expose the reinforcement for at least 50 mm on all sides. All such defective areas greater than 7800 square mm shall be outlined by saw cuts at least 25 mm deep. Defective areas less than 7800 square mm shall be outlined by a 25 mm deep cut with a core drill in lieu of sawing. All saw cuts shall be straight lines in a rectangular pattern in line with the formwork panels. After concrete removal, the surface shall be thoroughly cleaned by high pressure washing to remove all loose material. Surfaces shall be kept continually saturated for the first 12 of the 24 hours immediately before placing mortar and shall be damp but not wet at the time of commencing mortar placement. The Contractor, at his option, may use either hand-placed mortar or mortar placed with a mortar gun. If hand-placed mortar is used, the edges of the cut shall be perpendicular to the surface of the concrete. The prepared area shall be brush-coated with a thin coat of neat cement grout. The repair shall then be made using a stiff mortar, preshrunk by allowing the mixed mortar to stand for 30 to 45 minutes and then remixed, thoroughly tamped into place in thin layers. If hand-placed mortar is used, the Contractor shall test each repair area for drumminess by firm tapping with a hammer and shall inspect for cracks, both in the presence of the Contracting Officer's representative, immediately before completion of the contract, and shall replace any showing drumminess or cracking. If mortar placed with a mortar gun is used, the gun shall be a small compressed air-



operated gun to which the mortar is slowly hand fed and which applies the mortar to the surface as a high-pressure stream, as approved. Repairs made using shotcrete equipment will not be accepted. The mortar used shall be the same mortar as specified for damp-pack mortar repair. If gun-placed mortar is used, the edges of the cut shall be beveled toward the center at a slope of 1:1. All surface applied mortar repairs shall be continuously moist cured for at least 7 days. Moist curing shall consist of several layers of saturated burlap applied to the surface immediately after placement is complete and covered with polyethylene sheeting, all held closely in place by a sheet of plywood or similar material rigidly braced against it. Burlap shall be kept continually wet.

#### 3.9.2.2 Repair of Deep and Large Defects

Deep and large defects will be those that are more than 150 mm deep and also have an average diameter at the surface more than 450 mm or that are otherwise so identified by the Project Office. Such defects shall be repaired as specified herein or directed, except that defects which affect the strength of the structure shall not be repaired and that portion of the structure shall be completely removed and replaced. Deep and large defects shall be repaired by procedures approved in advance including forming and placing special concrete using applied pressure during hardening. Preparation of the repair area shall be as specified for surface application of mortar. In addition, the top edge (surface) of the repair area shall be sloped at approximately 20 degrees from the horizontal, upward toward the side from which concrete will be placed. The special concrete shall be a concrete mixture with low water content and low slump, and shall be allowed to age 30 to 60 minutes before use. Concrete containing a specified expanding admixture may be used in lieu of the above mixture; the paste portion of such concrete mixture shall be designed to have an expansion between 2.0 and 4.0 percent when tested in accordance with ASTM C 940. A full width "chimney" shall be provided at the top of the form on the placing side to ensure filling to the top of the opening. A pressure cap shall be used on the concrete in the chimney with simultaneous tightening and revibrating the form during hardening to ensure a tight fit for the repair. The form shall be removed after 24 hours and immediately the chimney shall be carefully chipped away to avoid breaking concrete out of the repair; the surface of the repair concrete shall be dressed as required.

### 3.10 FINISHING UNFORMED SURFACES

The finish of all unformed surfaces shall meet the requirements of paragraph Tolerances in PART 1, when tested as specified herein.

#### 3.10.1 General

The ambient temperature of spaces adjacent to unformed surfaces being finished and of the base on which concrete will be placed shall be not less than 10 degrees C. In hot weather all requirements of paragraphs Hot Weather Requirements and Prevention of Plastic Shrinkage Cracking shall be met. Unformed surfaces that are not to be covered by additional concrete or backfill shall have a float finish, with additional finishing as specified below, and shall be true to the elevation shown on the drawings. Surfaces to receive additional concrete or backfill shall be brought to the elevation shown on the drawings, properly consolidated, and left true and regular. Unless otherwise shown on the drawings, exterior surfaces shall be sloped for drainage, as directed. Where drains are provided, interior floors shall

be evenly sloped to the drains. Joints shall be carefully made with a jointing or edging tool. The finished surfaces shall be protected from stains or abrasions. Grate tampers or "jitterbugs" shall not be used for any surfaces. The dusting of surfaces with dry cement or other materials or the addition of any water during finishing shall not be permitted. If bleedwater is present prior to finishing, the excess water shall be carefully dragged off or removed by absorption with porous materials such as burlap. During finishing operations, extreme care shall be taken to prevent over finishing or working water into the surface; this can cause "crazing" (surface shrinkage cracks which appear after hardening) of the surface. Any slabs with surfaces which exhibit significant crazing shall be removed and replaced. During finishing operations, surfaces shall be checked with a 10 foot straightedge, applied in both directions at regular intervals while the concrete is still plastic, to detect high or low areas.

#### 3.10.2 Rough Slab Finish

As a first finishing operation for unformed surfaces and as final finish for slabs to receive mortar setting beds, the surface shall receive a rough slab finish prepared as follows. The concrete shall be uniformly placed across the slab area, consolidated as previously specified, and then screeded with straightedge strikeoffs immediately after consolidation to bring the surface to the required finish level with no coarse aggregate visible. Side forms and screed rails shall be provided, rigidly supported, and set to exact line and grade. Allowable tolerances for finished surfaces apply only to the hardened concrete, not to forms or screed rails. Forms and screed rails shall be set true to line and grade. "Wet screeds" shall not be used.

#### 3.10.3 Floated Finish

Slabs to receive more than a rough slab finish shall next be given a wood float finish. The screeding shall be followed immediately by darbying or bull floating before bleeding water is present, to bring the surface to a true, even plane. Then, after the concrete has stiffened so that it will withstand a man's weight without imprint of more than 6 mm and the water sheen has disappeared, it shall be floated to a true and even plane free of ridges. Floating shall be performed by use of suitable hand floats or power driven equipment. Sufficient pressure shall be used on the floats to bring a film of moisture to the surface. Hand floats shall be made of wood, magnesium, or aluminum. Lightweight concrete or concrete that exhibits stickiness shall be floated with a magnesium float. Care shall be taken to prevent over-finishing or incorporating water into the surface.

#### 3.10.4 Troweled Finish

All floor slabs and pedestrian wearing surfaces shall be given a trowel finish. After floating is complete and after the surface moisture has disappeared, unformed surfaces shall be steel-troweled to a smooth, even, dense finish, free from blemishes including trowel marks. In lieu of hand finishing, an approved power finishing machine may be used in accordance with the directions of the machine manufacturer. Additional trowelings shall be performed, either by hand or machine until the surface has been troweled two (2) times, with waiting period between each. Care shall be taken to prevent blistering and if such occurs, troweling shall immediately be stopped and operations and surfaces corrected. A final hard steel troweling shall be done by hand, with the trowel tipped, and using hard pressure, when the surface is at a point that the trowel will produce a

ringing sound. The finished surface shall be thoroughly consolidated and shall be essentially free of trowel marks and be uniform in texture and appearance. The concrete mixture used for troweled finished areas shall be adjusted, if necessary, in order to provide sufficient fines (cementitious material and fine sand) to finish properly.

#### 3.10.4.1 Broomed

Slabs at entrances and balconies shall be given a broomed finish. After floating, the surface shall be lightly steel troweled, and then carefully scored by pulling a coarse fiber push-type broom across the surface. Brooming shall be transverse to traffic or at right angles to the slope of the slab. After the end of the curing period, the surface shall be vigorously broomed with a coarse fiber broom to remove all loose or semi-detached particles.

#### 3.11 FLOOR HARDENER

Interior floor surfaces in bulk storage areas of the Community Building shall be treated with floor hardener. Floor hardener shall be applied after the concrete has been cured and then air dried for 28 days. Three coats shall be applied, each the day after the preceding coat was applied. For the first application, 0.5 kg of the silocofluoride shall be dissolved in 4 liters of water. For subsequent applications, the solution shall be 1.0 kg of silicofluoride to each 4 liters of water. Floor should be mopped with clear water shortly after the preceding application has dried to remove encrusted salts. Proprietary hardeners shall be applied in accordance with the manufacturer's instructions. During application, area should be well ventilated. Precautions shall be taken when applying silicofluorides due to the toxicity of the salts. Any compound that contacts glass or aluminum should be immediately removed with clear water.

#### 3.12 CURING AND PROTECTION

##### 3.12.1 General

Concrete shall be cured by an approved method for the period of time given below:

Concrete with Type III cement	3 days
All other concrete	7 days

Immediately after placement, concrete shall be protected from premature drying, extremes in temperatures, rapid temperature change, mechanical injury and damage from rain and flowing water for the duration of the curing period. Air and forms in contact with concrete shall be maintained at a temperature above 10 degrees C for the first 3 days and at a temperature above 0 degrees C for the remainder of the specified curing period. Exhaust fumes from combustion heating units shall be vented to the outside of the enclosure, and heaters and ducts shall be placed and directed so as not to cause areas of overheating and drying of concrete surfaces or to create fire hazards. Materials and equipment needed for adequate curing and protection shall be available and at the site prior to placing concrete. No fire or excessive heat, including welding, shall be permitted near or in direct contact with the concrete at any time. Except as otherwise permitted by paragraph Membrane Forming Curing Compounds, moist curing shall be provided for any areas to receive floor hardener, any paint or other applied coating,

or to which other concrete is to be bonded. Concrete containing silica fume shall be initially cured by fog misting during finishing, followed immediately by continuous moist curing. Except for plastic coated burlap, impervious sheeting alone shall not be used for curing.

### 3.12.2 Moist Curing

Concrete to be moist-cured shall be maintained continuously wet for the entire curing period, commencing immediately after finishing. If water or curing materials used stain or discolor concrete surfaces which are to be permanently exposed, the concrete surfaces shall be cleaned as approved. When wooden forms are left in place during curing, they shall be kept wet at all times. If steel forms are used in hot weather, non-supporting vertical forms shall be broken loose from the concrete soon after the concrete hardens and curing water continually applied in this void. If the forms are removed before the end of the curing period, curing shall be carried out as on unformed surfaces, using suitable materials. Surfaces shall be cured by ponding, by continuous sprinkling, by continuously saturated burlap or cotton mats, or by continuously saturated plastic coated burlap. Burlap and mats shall be clean and free from any contamination and shall be completely saturated before being placed on the concrete. The Contractor shall have an approved work system to ensure that moist curing is continuous 24 hours per day.

### 3.12.3 Membrane Forming Curing Compounds

Concrete in the following areas may be cured with a pigmented curing compound or a nonpigmented curing compound containing a fugitive dye in lieu of moist curing. Membrane curing shall not be used on surfaces that are to receive any subsequent treatment depending on adhesion or bonding to the concrete, including surfaces to which a smooth finish is to be applied or other concrete to be bonded. However, a styrene acrylate or chlorinated rubber compound meeting ASTM C 309, Class B requirements, may be used for surfaces which are to be painted or are to receive bituminous roofing or waterproofing, or floors that are to receive adhesive applications of resilient flooring. The curing compound selected shall be compatible with any subsequent paint, roofing, waterproofing or flooring specified. Membrane curing compound shall not be used on surfaces that are maintained at curing temperatures with free steam. Curing compound shall be applied to formed surfaces immediately after the forms are removed and prior to any patching or other surface treatment except the cleaning of loose sand, mortar, and debris from the surface. All surfaces shall be thoroughly moistened with water. Curing compound shall be applied to slab surfaces as soon as the bleeding water has disappeared, with the tops of joints being temporarily sealed to prevent entry of the compound and to prevent moisture loss during the curing period. The curing compound shall be applied in a two-coat continuous operation by approved motorized power-spraying equipment operating at a minimum pressure of 500 kPa, at a uniform coverage of not more than 10 cubic meters per L for each coat, and the second coat shall be applied perpendicular to the first coat. Concrete surfaces which have been subjected to rainfall within 3 hours after curing compound has been applied shall be resprayed by the method and at the coverage specified. Surfaces on which clear compound is used shall be shaded from direct rays of the sun for the first 3 days. Surfaces coated with curing compound shall be kept free of foot and vehicular traffic, and from other sources of abrasion and contamination during the curing period.

#### 3.12.4 Ponding or Immersion

Concrete shall be continually immersed throughout the curing period. Water shall not be more than 10 degrees C less than the temperature of the concrete.

#### 3.12.5 Cold Weather Curing and Protection

When the daily ambient low temperature is less than 0 degrees C the temperature of the concrete shall be maintained above 5 degrees C for the first seven days after placing. During the period of protection removal, the air temperature adjacent to the concrete surfaces shall be controlled so that concrete near the surface will not be subjected to a temperature differential of more than 13 degrees C as determined by suitable temperature measuring devices furnished by the Government, as required, and installed adjacent to the concrete surface and 50 mm inside the surface of the concrete. The installation of the thermometers shall be made by the Contractor as directed.

### 3.13 SETTING BASE PLATES AND BEARING PLATES

After being properly positioned, column base plates, bearing plates for beams and similar structural members, and machinery and equipment base plates shall be set to the proper line and elevation with damp-pack bedding mortar, except where nonshrink grout is indicated. The thickness of the mortar or grout shall be approximately 1/24 the width of the plate, but not less than 20 mm. Concrete and metal surfaces in contact with grout shall be clean and free of oil and grease, and concrete surfaces in contact with grout shall be damp and free of laitance when grout is placed. Nonshrink grout shall be used where shown on the plans.

#### 3.13.1 Damp-Pack Bedding Mortar

Damp-pack bedding mortar shall consist of 1 part cement and 2-1/2 parts fine aggregate having water content such that a mass of mortar tightly squeezed in the hand will retain its shape but will crumble when disturbed. The space between the top of the concrete and bottom of the bearing plate or base shall be packed with the bedding mortar by tamping or ramming with a bar or rod until it is completely filled.

#### 3.13.2 Nonshrink Grout

Nonshrink grout shall be a ready-mixed material requiring only the addition of water. Water content shall be the minimum that will provide a flowable mixture and completely fill the space to be grouted without segregation, bleeding, or reduction of strength.

##### 3.13.2.1 Mixing and Placing of Nonshrink Grout

Mixing and placing shall be in conformance with the material manufacturer's instructions and as specified therein. Ingredients shall be thoroughly dry-mixed before adding water. After adding water, the batch shall be mixed for 3 minutes. Batches shall be of size to allow continuous placement of freshly mixed grout. Grout not used within 30 minutes after mixing shall be discarded. The space between the top of the concrete or machinery-bearing surface and the plate shall be filled solid with the grout. Forms shall be of wood or other equally suitable material for completely retaining the

grout on all sides and on top and shall be removed after the grout has set. The placed grout shall be carefully worked by rodding or other means to eliminate voids; however, overworking and breakdown of the initial set shall be avoided. Grout shall not be retempered or subjected to vibration from any source. Where clearances are unusually small, placement shall be under pressure with a grout pump. Temperature of the grout, and of surfaces receiving the grout, shall be maintained at 18 to 30 degrees C until after setting.

#### 3.13.2.2 Treatment of Exposed Surfaces

For metal-oxidizing nonshrink grout, exposed surfaces shall be cut back 25 mm and immediately covered with a parge coat of mortar consisting of 1 part portland cement and 2-1/2 parts fine aggregate by weight, with sufficient water to make a plastic mixture. The parge coat shall have a smooth finish. For other mortars or grouts, exposed surfaces shall have a smooth-dense finish and be left untreated. Curing shall comply with paragraph CURING AND PROTECTION.

#### 3.14 TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL

The Contractor shall perform the inspection and tests described below and, based upon the results of these inspections and tests, shall take the action required and shall submit specified reports. When, in the opinion of the Contracting Officer, the concreting operation is out of control, concrete placement shall cease and the operation shall be corrected. The laboratory performing the tests shall be onsite and shall conform with ASTM C 1077. Materials may be subjected to check testing by the Government from samples obtained at the manufacturer, at transfer points, or at the project site. The Government will inspect the laboratory, equipment, and test procedures prior to start of concreting operations and periodically thereafter for conformance with ASTM C 1077.

##### 3.14.1 Concrete Mixture

- a. Air Content Testing. Air content tests shall be made when test specimens are fabricated. In addition, at least two tests for air content shall be made on randomly selected batches of each separate concrete mixture produced during each 8-hour period of concrete production. Additional tests shall be made when excessive variation in workability is reported by the placing foreman or Government inspector. Tests shall be made in accordance with ASTM C 231 for normal weight concrete and ASTM C 173 for lightweight concrete. Test results shall be plotted on control charts which shall at all times be readily available to the Government and shall be submitted weekly. Copies of the current control charts shall be kept in the field by testing crews and results plotted as tests are made. When a single test result reaches either the upper or lower action limit, a second test shall immediately be made. The results of the two tests shall be averaged and this average used as the air content of the batch to plot on both the air content and the control chart for range, and for determining need for any remedial action. The result of each test, or average as noted in the previous sentence, shall be plotted on a separate control chart for each mixture on which an "average line" is set at the midpoint of the specified air content range from paragraph Air Entrainment. An upper warning limit and a lower warning limit line shall be set 1.0

percentage point above and below the average line, respectively. An upper action limit and a lower action limit line shall be set 1.5 percentage points above and below the average line, respectively. The range between each two consecutive tests shall be plotted on a secondary control chart for range where an upper warning limit is set at 2.0 percentage points and an upper action limit is set at 3.0 percentage points. Samples for air content may be taken at the mixer, however, the Contractor is responsible for delivering the concrete to the placement site at the stipulated air content. If the Contractor's materials or transportation methods cause air content loss between the mixer and the placement, correlation samples shall be taken at the placement site as required by the Contracting Officer, and the air content at the mixer controlled as directed.

- b. Air Content Corrective Action. Whenever points on the control chart for percent air reach either warning limit, an adjustment shall immediately be made in the amount of air-entraining admixture batched. As soon as practical after each adjustment, another test shall be made to verify the result of the adjustment. Whenever a point on the secondary control chart for range reaches the warning limit, the admixture dispenser shall be recalibrated to ensure that it is operating accurately and with good reproducibility. Whenever a point on either control chart reaches an action limit line, the air content shall be considered out of control and the concreting operation shall immediately be halted until the air content is under control. Additional air content tests shall be made when concreting is restarted.
- c. Slump Testing. In addition to slump tests which shall be made when test specimens are fabricated, at least four slump tests shall be made on randomly selected batches in accordance with ASTM C 143 for each separate concrete mixture produced during each 8-hour or less period of concrete production each day. Also, additional tests shall be made when excessive variation in workability is reported by the placing foreman or Government inspector. Test results shall be plotted on control charts which shall at all times be readily available to the Government and shall be submitted weekly. Copies of the current control charts shall be kept in the field by testing crews and results plotted as tests are made. When a single slump test reaches or goes beyond either the upper or lower action limit, a second test shall immediately be made. The results of the two tests shall be averaged and this average used as the slump of the batch to plot on both the control charts for slump and the chart for range, and for determining need for any remedial action. Limits shall be set on separate control charts for slump for each type of mixture. The upper warning limit shall be set at 12.5 mm below the maximum allowable slump specified in paragraph Slump in PART 1 for each type of concrete and an upper action limit line and lower action limit line shall be set at the maximum and minimum allowable slumps, respectively, as specified in the same paragraph. The range between each consecutive slump test for each type of mixture shall be plotted on a single control chart for range on which an upper action limit is set at 50 mm. Samples for slump shall be taken at the mixer. However, the Contractor is responsible for delivering the concrete to the placement site at the stipulated slump. If the Contractor's materials or

transportation methods cause slump loss between the mixer and the placement, correlation samples shall be taken at the placement site as required by the Contracting Officer, and the slump at the mixer controlled as directed.

- d. Slump Corrective Action. Whenever points on the control charts for slump reach the upper warning limit, an adjustment shall immediately be made in the batch weights of water and fine aggregate. The adjustments are to be made so that the total water content does not exceed that amount allowed by the maximum w/c ratio specified, based on aggregates which are in a saturated surface dry condition. When a single slump reaches the upper or lower action limit, no further concrete shall be delivered to the placing site until proper adjustments have been made. Immediately after each adjustment, another test shall be made to verify the correctness of the adjustment. Whenever two consecutive individual slump tests, made during a period when there was no adjustment of batch weights, produce a point on the control chart for range at or above the upper action limit, the concreting operation shall immediately be halted, and the Contractor shall take appropriate steps to bring the slump under control. Additional slump tests shall be made as directed.
- e. Temperature. The temperature of the concrete shall be measured when compressive strength specimens are fabricated. Measurement shall be in accordance with ASTM C 1064. The temperature shall be reported along with the compressive strength data.
- f. Strength Specimens. At least one set of test specimens shall be made, for compressive or flexural strength as appropriate, on each different concrete mixture placed during the day for each 380 cubic meters or portion thereof of that concrete mixture placed each day. Additional sets of test specimens shall be made, as directed by the Contracting Officer, when the mixture proportions are changed or when low strengths have been detected. A truly random (not haphazard) sampling plan shall be developed by the Contractor and approved by the Contracting Officer prior to the start of construction. The plan shall assure that sampling is done in a completely random and unbiased manner. A set of test specimens for concrete with a 28-day specified strength per paragraph Strength Requirements in PART 1 shall consist of four specimens, two to be tested at 7 days and two at 28 days. Test specimens shall be molded and cured in accordance with ASTM C 31 and tested in accordance with ASTM C 39 for test cylinders and ASTM C 78 for test beams. Results of all strength tests shall be reported immediately to the Contracting Officer. Quality control charts shall be kept for individual strength "tests", ("test" as defined in paragraph Strength Requirements in PART 1) moving average of last 3 "tests" for strength, and moving average for range for the last 3 "tests" for each mixture. The charts shall be similar to those found in ACI 214.3R.



### 3.14.2 Inspection Before Placing

Foundations, construction joints, forms, and embedded items shall be inspected by the Contractor in sufficient time prior to each concrete placement in order to certify to the Contracting Officer that they are ready to receive concrete. The results of each inspection shall be reported in writing.

### 3.14.3 Placing

The placing foreman shall supervise placing operations, shall determine that the correct quality of concrete or grout is placed in each location as specified and as directed by the Contracting Officer, and shall be responsible for measuring and recording concrete temperatures and ambient temperature hourly during placing operations, weather conditions, time of placement, volume placed, and method of placement. The placing foreman shall not permit batching and placing to begin until it has been verified that an adequate number of vibrators in working order and with competent operators are available. Placing shall not be continued if any pile of concrete is inadequately consolidated. If any batch of concrete fails to meet the temperature requirements, immediate steps shall be taken to improve temperature controls.

### 3.14.4 Vibrators

The frequency and amplitude of each vibrator shall be determined in accordance with COE CRD-C 521 prior to initial use and at least once a month when concrete is being placed. Additional tests shall be made as directed when a vibrator does not appear to be adequately consolidating the concrete. The frequency shall be determined while the vibrator is operating in concrete with the tachometer being held against the upper end of the vibrator head while almost submerged and just before the vibrator is withdrawn from the concrete. The amplitude shall be determined with the head vibrating in air. Two measurements shall be taken, one near the tip and another near the upper end of the vibrator head, and these results averaged. The make, model, type, and size of the vibrator and frequency and amplitude results shall be reported in writing. Any vibrator not meeting the requirements of paragraph Consolidation, shall be immediately removed from service and repaired or replaced.

### 3.14.5 Curing Inspection

- a. Moist Curing Inspections. At least once each shift, and not less than twice per day on both work and non-work days, an inspection shall be made of all areas subject to moist curing. The surface moisture condition shall be noted and recorded.
- b. Moist Curing Corrective Action. When a daily inspection report lists an area of inadequate curing, immediate corrective action shall be taken, and the required curing period for those areas shall be extended by 1 day.
- c. Membrane Curing Inspection. No curing compound shall be applied until the Contractor has verified that the compound is properly mixed and ready for spraying. At the end of each operation, the Contractor shall estimate the quantity of compound used by measurement of the container and the area of concrete surface

covered, shall compute the rate of coverage in square meters per Liter, and shall note whether or not coverage is uniform.

- d. Membrane Curing Corrective Action. When the coverage rate of the curing compound is less than that specified or when the coverage is not uniform, the entire surface shall be sprayed again.
- e. Sheet Curing Inspection. At least once each shift and once per day on non-work days, an inspection shall be made of all areas being cured using impervious sheets. The condition of the covering and the tightness of the laps and tapes shall be noted and recorded.
- f. Sheet Curing Corrective Action. When a daily inspection report lists any tears, holes, or laps or joints that are not completely closed, the tears and holes shall promptly be repaired or the sheets replaced, the joints closed, and the required curing period for those areas shall be extended by 1 day.

#### 3.14.6 Cold-Weather Protection

At least once each shift and once per day on non-work days, an inspection shall be made of all areas subject to cold-weather protection. Any deficiencies shall be noted, corrected, and reported.

#### 3.14.7 Reports

All results of tests or inspections conducted shall be reported informally as they are completed and in writing daily. A weekly report shall be prepared for the updating of control charts covering the entire period from the start of the construction season through the current week. During periods of cold-weather protection, reports of pertinent temperatures shall be made daily. These requirements do not relieve the Contractor of the obligation to report certain failures immediately as required in preceding paragraphs. Such reports of failures and the action taken shall be confirmed in writing in the routine reports. The Contracting Officer has the right to examine all contractor quality control records.

## SECTION 03410

## PLANT-PRECAST STRUCTURAL CONCRETE

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS  
(AASHTO)

AASHTO HB14 (1992) Highway Bridges

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 211.1 (1991) Selecting Proportions for Normal, Heavyweight, and Mass Concrete

ACI 214 (1977; R 1989) Evaluation of Strength Test Results of Concrete

ACI 301 (1994) Structural Concrete for Buildings

ACI 304R (1989) Measuring, Mixing, Transporting, and Placing Concrete

ACI 305R (1991) Hot Weather Concreting

ACI 306.1 (1990) Cold Weather Concreting

ACI 309R (1987) Consolidation of Concrete

ACI 315 (1994) Details and Detailing of Concrete Reinforcement

ACI 318M (1995) Building Code Requirements for Reinforced Concrete (Metric)

ACI 318 (1995) Building Code Requirements for Reinforced Concrete

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A135.4 (1995) Basic Hardboard

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 27/A 27M (1993) Steel Castings, Carbon, for General Application

ASTM A 36/A 36M (1994) Carbon Structural Steel

ASTM A 47M	(1990) Ferritic Malleable Iron Castings (Metric)
ASTM A 47	(1990) Ferritic Malleable Iron Castings
ASTM A 123	(1989; Rev. A) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153/A 153M	(1995) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 167	(1994; Rev. A) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 185	(1994) Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
ASTM A 283/A 283M	(1993; Rev. A) Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A 307	(1994) Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
ASTM A 325M	(1993) High-Strength Bolts for Structural Steel Joints (Metric)
ASTM A 325	(1994) Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 449	(1993) Quenched and Tempered Steel Bolts and Studs
ASTM A 496	(1994) Steel Wire, Deformed, for Concrete Reinforcement
ASTM A 497	(1995) Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement
ASTM A 563M	(1993) Carbon and Alloy Steel Nuts (Metric)
ASTM A 563	(1994) Carbon and Alloy Steel Nuts
ASTM A 615/A 615M	(1995; Rev. B) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A 616/A 616M	(1995; Rev. B) Rail-Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A 617/A 617M	(1995; Rev. B) Axle-Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A 653/A 653M	(1994) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 706/A 706M	(1995; Rev. A) Low-Alloy Steel Deformed Bars for Concrete Reinforcement

ASTM A 780	(1993; Rev. A) Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM C 31	(1991) Making and Curing Concrete Test Specimens in the Field
ASTM C 33	(1993) Concrete Aggregates
ASTM C 39	(1994) Compressive Strength of Cylindrical Concrete Specimens
ASTM C 94	(1994) Ready-Mixed Concrete
ASTM C 143	(1990; Rev. A) Slump of Hydraulic Cement Concrete
ASTM C 150	(1995) Portland Cement
ASTM C 172	(1990) Sampling Freshly Mixed Concrete
ASTM C 185	(1995) Air Content of Hydraulic Cement Mortar
ASTM C 260	(1995) Air-Entraining Admixtures for Concrete
ASTM C 330	(1989) Lightweight Aggregates for Structural Concrete
ASTM C 494	(1992) Chemical Admixtures for Concrete
ASTM C 595M	(1995) Blended Hydraulic Cements (Metric)
ASTM C 595	(1994; Rev. A) Blended Hydraulic Cements
ASTM C 618	(1995) Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
ASTM C 989	(1994; Rev. A) Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
ASTM C 1107	(1991; Rev. A) Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM F 436M	(1993) Hardened Steel Washers (Metric)
ASTM F 436	(1993) Hardened Steel Washers
ASTM F 844	(1990) Washers, Steel, Plain (Flat), Unhardened for General Use

## AMERICAN WELDING SOCIETY, INC. (AWS)

AWS D1.1	(1994) Structural Welding Code Steel
AWS D1.4	(1992) Structural Welding Code Reinforcing Steel

## PRECAST/PRESTRESSED CONCRETE INSTITUTE (PCI)

PCI MNL-116	(1985) Quality Control for Plants and Production of Precast Prestressed Concrete Products
PCI MNL-120	(1992) Design Handbook - Precast and Prestressed Concrete
PCI MNL-124	(1989) Fire Resistance of Precast Prestressed Concrete

## UNDERWRITERS LABORATORIES INC. (UL)

UL FRD	(1995) Fire Resistance Directory
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## 1.2 PRECAST MEMBERS

The work includes the provision of precast non-prestressed concrete herein referred to as precast members. Precast members shall be the product of a manufacturer specializing in the production of precast concrete members. In the ACI publications, the advisory provisions shall be considered to be mandatory, as though the word "shall" has been substituted for "should" wherever it appears; reference to the "Building Official," the "Structural Engineer" and the "Architect/Engineer" shall be interpreted to mean the Contracting Officer.

## 1.3 SUBMITTALS

Submit the following in accordance with Section 01300, "Submittal Procedures."

SD-01 Data

Anchorage and Lifting Inserts and Devices; GA.

Bearing Pads; GA.

Cast-in Embedded Items and Connectors; GA.

Connection Devices; GA.

Precast Concrete Members Design Calculations; GA.

Submit calculations reflecting design conforming to requirements of paragraph entitled "Precast Concrete Member Design." Design calculations and drawings of precast members (including connections) shall be prepared and sealed by a registered professional engineer demonstrating compliance with indicated loading conditions, and submitted for approval prior to fabrication. Submit calculations for volume change as part of the design calculations.

Concrete Mix Design; GA.

Thirty days minimum prior to concrete placement, submit a mix design for each strength and type of concrete. Include a complete list of materials including type; brand; source and amount of cement, pozzolan, and admixtures; and applicable reference specifications.

Concrete Mix Design for Repair of Surface Defects; GA.

Precast Concrete Wall Panel Connection and Embedment Design Calculations; GA.

Submit design calculations prepared and sealed by a professional engineer demonstrating compliance with the indicating connection and embedment details. Structural embedded anchorage and connections to panels shall be designed to withstand gravity loads, live loads, dynamic loads, and any volume change stresses inherent in the structure, and loads indicated.

Manufacturer's data shall be submitted for items 1 through 4 listed above.

#### SD-04 Drawings

Drawings of Precast Members; GA.

Submit drawings indicating complete information for the fabrication, handling, and erection of the precast member. Drawings shall not be reproductions of contract drawings. Design calculations and drawings of precast members (including connections) shall be prepared and sealed by a registered professional engineer, and submitted for approval prior to fabrication. The drawings shall indicate, as a minimum, the following information:

- a. Marking of members for erection
- b. Connections for work of other trades
- c. Connections between members, and connections between members and other construction
- d. Location and size of openings
- e. Headers for openings
- f. Joints between members, and joints between members and other construction
- g. Reinforcing details
- h. Material properties of steel and concrete used
- i. Lifting and erection inserts
- j. Dimensions and surface finishes of each member
- k. Erection sequence and handling requirements

- l. All loads used in design (such as live, dead, handling, and erection)
- m. Bracing/shoring required
- n. Areas to receive toppings, topping thickness.
- o. Cross-section, and edge details.
- p. Layout, dimensions, and identification of each panel, corresponding to installation sequence.
- q. Setting drawings, instructions, and directions for installation of concrete inserts.
- r. Location and details of anchorage devices and lifting devices embedded in panels, and connection details to building

#### SD-06 Instructions

Installation of Precast Concrete Wall Panel; GA.

Include precast concrete wall panel manufacturer's written recommendations for installation.

#### SD-08 Statements

Fabrication; FIO.

Submit quality control procedures established in accordance with PCI MNL-116 by the precast manufacturer.

#### SD-09 Reports

Fly ash Test; FIO.

Pozzolan Test; FIO.

Ground Slag Test; FIO.

Submit results of fly ash, pozzolan, and ground slag chemical and physical analysis performed within 6 months of submittal date. Provide copies of test reports showing that the mix has been successfully tested to produce concrete with the properties specified and will be suitable for the job conditions. Obtain approval before concrete placement.

Contractor-furnished Mix Design; GA.

Submit copies of test reports showing that the mix has been successfully tested to produce concrete with the properties specified and will be suitable for the job conditions. Obtain approval before concrete placement.

Strength Tests; FIO.

Submit commercial testing results in accordance with PCI MNL-116 and as required in paragraph entitled "Sampling and Testing."



## SD-14 Samples

Surface Finish; FIO.

Submit two 300 by 300 by 50 mm thick sample panels representative of the color and finish for each type of precast member to illustrate quality, color, and texture of both exposed-to-view surface finish and finish of panel surfaces that will be concealed by other construction.

## SD-18 Records

Concrete Batch Ticket Information; FIO.

ASTM C 94. Submit mandatory batch ticket information for each load of ready-mixed concrete.

## 1.4 QUALITY CONTROL

## 1.4.1 Precast Concrete Member Design

ACI 318M and the PCI MNL-120. Design precast members (including connections) for the design load conditions and spans indicated, and for additional loads imposed by openings and supports of the work of other trades. Design precast members for handling without cracking in accordance with the PCI MNL-120. Precast members shall have a fire rating of 2-hours in accordance with UL FRD, or as designed in accordance with PCI MNL-124. Concrete toppings shall be used in establishing the design strength of the precast members.

## 1.4.2 PCI Quality Certifications

PCI MNL-116. At the precast manufacturer's option, in lieu of core samples, ACI 318M, full-scale load tests may be performed. Perform on randomly selected members, as directed by the Contracting Officer.

## 1.4.2.1 Product Quality Control

Plants shall be certified by the PCI Plant Certification Program for Category C3 or C4 work.

## 1.5 DELIVERY AND STORAGE

Lift and support precast members at the lifting and supporting points indicated on the shop drawings. Store precast members off the ground. Separate stacked precast members by battens across the full width of each bearing point. Protect from weather, marring, damage, and overload.

## 1.6 FACTORY INSPECTION

At the option of the Contracting Officer, precast units shall be inspected by the QC Representative prior to being transported to the job site. The Contractor shall give notice 14 days prior to the time the units will be available for plant inspection. Neither the exercise nor waiver of inspection at the plant will affect the Government's right to enforce contractual provisions after units are transported or erected.

## 2 PRODUCTS

### 2.1 CONTRACTOR-FURNISHED MIX DESIGN

ACI 318M. The minimum compressive strength of concrete at 28 days shall be 35 MPa, unless otherwise indicated. Add air-entraining admixtures at the mixer to produce between 4 and 6 percent air by volume.

### 2.2 MATERIALS

#### 2.2.1 Cement

ASTM C 150, Type I, II, or III; or ASTM C 595M Type IP(MS) or IS(MS) blended cement, except as modified herein. The blended cement shall consist of a mixture of ASTM C 150 cement and one of the following materials: ASTM C 618 pozzolan or fly ash, or ASTM C 989 ground iron blast furnace slag. The pozzolan/fly ash content shall not exceed 25 percent by weight of the total cementitious material. For exposed concrete, use one manufacturer for each type of cement, ground slag, fly ash, and pozzolan.

##### 2.2.1.1 Fly Ash and Pozzolan

ASTM C 618, Type N, F, or C, except that the maximum allowable loss on ignition shall be 6 percent for Type N and F.

##### 2.2.1.2 Ground Iron Blast-Furnace Slag

ASTM C 989, Grade 100 or 120.

#### 2.2.2 Water

Water shall be fresh, clean, and potable.

#### 2.2.3 Aggregates

##### 2.2.3.1 Aggregates Selection

ASTM C 33, Size 67 or 7, except as modified herein. Obtain aggregates for exposed concrete surfaces from one source. The optional method of reducing the No. 50 and No. 100 sieve aggregates does not apply. Aggregates shall not contain any substance that may be deleteriously reactive with the alkalis in the cement. Aggregate shall not contain slag or crushed concrete.

##### 2.2.3.2 Aggregates for Lightweight Concrete

ASTM C 330.

#### 2.2.4 Grout

##### 2.2.4.1 Nonshrink Grout

ASTM C 1107.

#### 2.2.4.2 Cementitious Grout

Shall be a mixture of portland cement, sand, and water. Proportion one part cement to approximately 2.5 parts sand, with the amount of water based on placement method. Provide air entrainment for grout exposed to the weather.

#### 2.2.5 Admixtures

##### 2.2.5.1 Air-Entraining

ASTM C 260.

##### 2.2.5.2 Accelerating

ASTM C 494, Type C or E.

##### 2.2.5.3 Water Reducing

ASTM C 494, Type A, E, or F.

#### 2.2.6 Reinforcement

##### 2.2.6.1 Reinforcing Bars

ASTM A 706/A 706M, Grade 400; ASTM A 615/A 615M, Grade 400; ASTM A 617/A 617M, Grade 400; or ASTM A 616/A 616M, Grade 400.

##### 2.2.6.2 Welded Wire Fabric

ASTM A 185 or ASTM A 497.

##### 2.2.6.3 Spiral Wire

ASTM A 82.

##### 2.2.6.4 Supports for Concrete Reinforcement

Include bolsters, chairs, spacers, and other devices necessary for proper spacing, supporting, and fastening in place.

- a. Supports: ASTM A 615/A 615M, wire-type reinforcing bars and welded wire fabric.
- b. Legs of supports in contact with formwork: Stainless steel, ASTM A 167, Type 302 or Type 304.

#### 2.2.7 Metal Accessories

Provide ASTM A 123 or ASTM A 153/A 153M galvanized.

##### 2.2.7.1 Inserts

###### 2.2.7.1.1 Threaded-Type Concrete Inserts

ASTM A 47M, Grade 22010, or may be medium strength cast steel conforming to ASTM A 27/A 27M, Grade 415-205. Provide galvanized ferrous casting having enlarged base with two nailing lugs minimum length less than the thickness

of panel less 20 mm, and internally threaded to receive 20 mm diameter machine bolt. Ferrous castings shall be ferritic malleable iron.

#### 2.2.7.1.2 Wedge-Type Concrete Inserts

Provide galvanized, box-type ferrous castings with integral anchor loop at back of box to accept 20 mm diameter bolts having special wedge-shaped head. Provide ferrous castings ASTM A 47M, Grade 22010, ferritic malleable iron or ASTM A 27/A 27M, Grade 415-205,, medium-strength cast steel.

#### 2.2.7.1.3 Slotted-Type Concrete Inserts

Provide pressed steel plate, welded construction, box type with slot to receive 20 mm square head bolt, and provide lateral adjustment of bolt. Length of insert body, less anchorage lugs, shall be 110 mm minimum. Provide insert with knockout cover. Steel plate shall be 3 mm minimum thickness, ASTM A 283/A 283M, Grade C.

#### 2.2.7.2 Structural Steel

ASTM A 36/A 36M.

##### 2.2.7.2.1 Embedded Plates and Clip Angles

ASTM A 36/A 36M, galvanized, ferrous metal plate connectors for attachment to the structural framing using manufacturer standard construction procedures. Headed studs shall use 400 MPa steel with construction conforming to AWS D1.1, Type B. Deformed bar anchors shall conform to ASTM A 496.

##### 2.2.7.3 Bolts

ASTM A 307; ASTM A 325M.

##### 2.2.7.4 Nuts

ASTM A 563M. , Grade A, plain, square-type nuts where required for slotted-type concrete inserts.

##### 2.2.7.5 Washers

ASTM F 844 washers for ASTM A 307 bolts, and ASTM F 436M washers for ASTM A 325M bolts.

#### 2.2.8 Form Materials

Provide forms and form-facing materials of wood, metal, plastic, or other approved material to produce concrete having the specified finish. Construct forms mortar-tight and of sufficient strength to withstand all pressures due to concrete placing operations and temperature changes within the specified fabrication tolerances.

#### 2.2.9 Bearing Pads

##### 2.2.9.1 Elastomeric

AASHTO HB14, for plain neoprene bearings.

#### 2.2.9.2 Hardboard (Interior Only)

ANSI A135.4, class as specified by the precast manufacturer.

### 2.3 FABRICATION

PCI MNL-116 unless specified otherwise.

#### 2.3.1 Forms

Brace forms to prevent deformation. Forms shall produce a smooth, dense surface. Chamfer exposed edges of columns and beams 20 mm, unless otherwise indicated. Provide threaded or snap-off type form ties.

#### 2.3.2 Reinforcement Placement

ACI 318M for placement and splicing. Reinforcement may be preassembled before placement in forms. Provide exposed connecting bars, or other approved connection methods, between precast and cast-in-place construction. Remove any excess mortar that adheres to the exposed connections.

#### 2.3.3 Concrete

##### 2.3.3.1 Concrete Mixing

ASTM C 94. Mixing operations shall produce batch-to-batch uniformity of strength, consistency, and appearance.

##### 2.3.3.2 Concrete Placing

ACI 304R, ACI 305R for hot weather concreting, ACI 306.1 for cold weather concreting, and ACI 309R, unless otherwise specified.

##### 2.3.3.3 Concrete Curing

Commence curing immediately following the initial set and completion of surface finishing. Provide curing procedures to keep the temperature of the concrete between 10 and 90 degrees C. When accelerated curing is used, apply heat at controlled rate and uniformly along the casting beds. Monitor temperatures at various points in a product line in different casts.

#### 2.3.4 Surface Finish

Repairs located in a bearing area shall be approved by the Contracting Officer prior to repairs. Precast members containing hairline cracks which are visible and are less than 0.5 mm in width, may be accepted, except that cracks larger than 0.1 mm in width for surfaces exposed to the weather shall be repaired. Precast members which contain cracks greater than 0.5 mm in width shall be approved by the Contracting Officer, prior to being repaired. Any precast member that is structurally impaired or contains honeycombed section deep enough to expose reinforcing shall be rejected.

##### 2.3.4.1 Unformed Surfaces

Provide a steel troweled finish.

#### 2.3.4.2 Formed Surfaces

PCI MNL-116 (Appendix A - Commentary), Chapter 3, for grades of surface finishes.

- a. Unexposed Surfaces: Provide a standard grade surface finish.
- b. Exposed Surfaces: Provide a standard grade surface finish. The combined area of acceptable defective areas shall not exceed 0.2 percent of the exposed to view surface area, and the patches shall be indistinguishable from the surrounding surfaces when dry.

### 3 EXECUTION

#### 3.1 SURFACE REPAIR

Prior to erection, and again after installation, precast members shall be checked for damage, such as cracking, spalling, and honeycombing. As directed by the Contracting Officer, precast members that do not meet the surface finish requirements specified in Part 2 in paragraph entitled "Surface Finish" shall be repaired, or removed and replaced with new precast members.

#### 3.2 ERECTION

Precast members shall be erected after the concrete has attained the specified compressive strength, unless otherwise approved by the precast manufacturer. Erect in accordance with the approved shop drawings. PCI MNL-116 and PCI MNL-120 (Chapter 8), for tolerances. Brace precast members, unless design calculations submitted with the shop drawings indicate bracing is not required. Follow the manufacturer's recommendations for maximum construction loads. Place precast members level, plumb, square, and true within tolerances. Align member ends.

#### 3.3 BEARING SURFACES

Shall be flat, free of irregularities, and properly sized. Size bearing surfaces to provide for the indicated clearances between the precast member and adjacent precast members or adjoining field placed surfaces. Correct bearing surface irregularities with nonshrink grout. Provide bearing pads where indicated or required. Do not use hardboard bearing pads in exterior locations. Place precast members at right angles to the bearing surface, unless indicated otherwise, and draw-up tight without forcing or distortion, with sides plumb.

#### 3.4 ANCHORAGE

Provide anchorage for fastening work in place. Conceal fasteners where practicable. Make threaded connections up tight and nick threads to prevent loosening.

#### 3.5 WELDING

AWS D1.4 for welding connections and reinforcing splices. Protect the concrete and other reinforcing from heat during welding. Weld continuously along the entire area of contact except where tack welding is permitted. Do

not tack weld exposed connections. Grind smooth visible welds in the finished installation.

### 3.6 OPENINGS

Holes or cuts requiring reinforcing to be cut, which are not indicated on the approved shop drawing, shall only be made with the approval of the Contracting Officer and the precast manufacturer. Drill holes less than 12 inches in diameter with a diamond tipped core drill.

### 3.7 GALVANIZING REPAIR

Repair damage to galvanized coatings using ASTM A 780 zinc rich paint for galvanized surfaces damaged by handling, transporting, cutting, welding, bolting, or acid washing. Do not heat surfaces to which repair paint has been applied.

### 3.8 GROUTING

Clean and fill keyways between precast members, and other indicated areas, solidly with nonshrink grout or cementitious grout. Provide reinforcing where indicated. Remove excess grout before hardening.

### 3.9 SEALANTS

Provide as indicated and as specified in Section 07920, "Joint Sealants."

### 3.10 CONCRETE TOPPING

Provide as indicated and as specified in Section 03300, "Cast-In-Place Concrete."

### 3.11 SAMPLING AND TESTING

#### 3.11.1 Product Quality Control

PCI MNL-116 for PCI enrolled plants. Where panels are manufactured by specialists in plants not currently enrolled in the PCI "Quality Control Program," provide a product quality control system in accordance with PCI MNL-116 and perform concrete and aggregate quality control testing using an approved, independent commercial testing laboratory. Submit test results to the Contracting Officer.

##### 3.11.1.1 Aggregate Tests

ASTM C 33. Perform one test for each aggregate size, including determination of the specific gravity.

##### 3.11.1.2 Strength Tests

ASTM C 172. Provide ASTM C 39 and ASTM C 31 compression tests. Perform ASTM C 143 slump tests. Mold six cylinders each day or for every 15 cubic meters of concrete placed, whichever is greater. Perform strength tests using two cylinders at 7 days and two at 28 days. Cure four cylinders in the same manner as the panels and place at the point where the poorest curing conditions are offered. Moist cure two cylinders and test at 28 days.

### 3.11.1.3 Changes in Proportions

If, the compressive strength falls below that specified, adjust the mix proportions and water content and make necessary changes in the temperature, moisture, and curing procedures to secure the specified strength. Notify the Contracting Officer of all changes.

### 3.11.1.4 Strength Test Results

Evaluate compression test results at 28 days in accordance with ACI 214 using a coefficient of variation of 20 percent. Evaluate the strength of concrete by averaging the test results (two specimens) of standard cylinders tested at 28 days. Not more than 20 percent of the individual tests shall have an average compressive strength less than the specified ultimate compressive strength.

### 3.11.2 Rejection

Panels in place may be rejected for any one of the following product defects or installation deficiencies remaining after repairs and cleaning have been accomplished. "Visible" means visible to a person with normal eyesight when viewed from a distance of 6 m in broad daylight.

- a. Nonconformance to specified tolerances.
- b. Air voids (bugholes or blowholes) larger than 10 mm diameter.
- c. Visible casting lines.
- d. Visible from joints.
- e. Visible irregularities.
- f. Visible stains on panel surfaces.
- g. Visible differences between panel and approved sample.
- h. Visible nonuniformity of textures or color.
- i. Visible areas of backup concrete bleeding through the facing concrete.
- j. Visible foreign material embedded in the face.
- k. Visible repairs.
- l. Visible reinforcement shadow lines.
- m. Visible cracks.

### 3.11.3 Field Quality Control

Perform field inspection of member connections. The Contracting Officer shall be notified in writing of defective welds, bolts, nuts and washers within 7 working days of the date of inspection. All defective connections



or welds shall be removed and rewelded or repaired as required by the Contracting Officer.

#### 3.11.3.1 Welded Connection Visual Inspection

AWS D1.1, furnish the services of AWS-certified welding inspector for erection inspections. Welding inspector shall visually inspect all welds and identify all defective welds.

## SECTION 03412

## PLANT-PRECAST PRESTRESSED STRUCTURAL CONCRETE

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS  
(AASHTO)

AASHTO HB14 (1992) Highway Bridges

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 214 (1977; R 1989) Evaluation of Strength Test Results of Concrete

ACI 304R (1989) Measuring, Mixing, Transporting, and Placing Concrete

ACI 305R (1991) Hot Weather Concreting

ACI 306.1 (1990) Cold Weather Concreting

ACI 309R (1987) Consolidation of Concrete

ACI 318M (1995) Building Code Requirements for Reinforced Concrete (Metric)

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A135.4 (1995) Basic Hardboard

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 27/A 27M (1993) Steel Castings, Carbon, for General Application

ASTM A 36/A 36M (1994) Carbon Structural Steel

ASTM A 47M (1990) Ferritic Malleable Iron Castings (Metric)

ASTM A 82 (1995) Steel Wire, Plain, for Concrete Reinforcement

ASTM A 123 (1989; Rev. A) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A 153/A 153M (1995) Zinc Coating (Hot-Dip) on Iron and Steel Hardware

ASTM A 167	(1994; Rev. A) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 185	(1994) Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
ASTM A 283/A 283M	(1993; Rev. A) Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A 307	(1994) Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
ASTM A 325M	(1993) High-Strength Bolts for Structural Steel Joints (Metric)
ASTM A 416/A 416M	(1994; Rev. A) Steel Strand, Uncoated Seven-Wire for Prestressed Concrete
ASTM A 421	(1991) Uncoated Stress-Relieved Steel Wire for Prestressed Concrete
ASTM A 496	(1994) Steel Wire, Deformed, for Concrete Reinforcement
ASTM A 497	(1995) Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement
ASTM A 615/A 615M	(1995; Rev. B) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A 616/A 616M	(1995; Rev. B) Rail-Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A 617/A 617M	(1995; Rev. B) Axle-Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A 706/A 706M	(1995; Rev. BC Low-Alloy Steel Deformed Bars for Concrete Reinforcement
ASTM C 31	(1991) Making and Curing Concrete Test Specimens in the Field
ASTM C 33	(1993) Concrete Aggregates
ASTM C 39	(1994) Compressive Strength of Cylindrical Concrete Specimens
ASTM C 94	(1994) Ready-Mixed Concrete
ASTM C 143	(1990; Rev. A) Slump of Hydraulic Cement Concrete
ASTM C 150	(1995) Portland Cement
ASTM C 172	(1990) Sampling Freshly Mixed Concrete
ASTM C 260	(1995) Air-Entraining Admixtures for Concrete

ASTM C 330	(1989) Lightweight Aggregates for Structural Concrete
ASTM C 494	(1992) Chemical Admixtures for Concrete
ASTM C 595M	(1995) Blended Hydraulic Cements (Metric)
ASTM C 618	(1995) Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
ASTM C 989	(1994; Rev. A) Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
ASTM C 1107	(1991; Rev. A) Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM F 436M	(1993) Hardened Steel Washers (Metric)
ASTM F 844	(1990) Washers, Steel, Plain (Flat), Unhardened for General Use

## AMERICAN WELDING SOCIETY, INC. (AWS)

AWS D1.1	(1994) Structural Welding Code Steel
AWS D1.4	(1992) Structural Welding Code Reinforcing Steel

## PRECAST/PRESTRESSED CONCRETE INSTITUTE (PCI)

PCI MNL-116	(1985) Quality Control for Plants and Production of Precast Prestressed Concrete Products
PCI MNL-120	(1992) Design Handbook - Precast and Prestressed Concrete
PCI MNL-124	(1989) Fire Resistance of Precast Prestressed Concrete

## UNDERWRITERS LABORATORIES INC. (UL)

UL FRD	(1995) Fire Resistance Directory
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## 1.2 DESCRIPTION OF WORK

The work includes the provision of precast, prestressed concrete herein referred to as prestressed members. Prestressed members shall be the product of a manufacturer specializing in the production of precast prestressed concrete members. In the ACI publications, the advisory provisions shall be considered to be mandatory, as though the word "shall" has been substituted for "should" wherever it appears; reference to the "Building Official," the "Structural Engineer" and the "Architect/Engineer" shall be interpreted to mean the Contracting Officer.

### 1.3 SUBMITTALS

Submit the following in accordance with Section entitled "Submittal Procedures."

#### SD-04 Drawings

Precast Prestressed Concrete Members; GA.

Submit drawings indicating complete information for the fabrication, handling, and erection of the prestressed member. Drawings shall not be reproductions of contract drawings. Design calculations and drawings of prestressed members (including connections) shall be prepared and sealed by a registered professional engineer, and submitted for approval prior to fabrication. The drawings shall indicate, as a minimum, the following information:

- a. Marking of members for erection;
- b. Connections for work of other trades;
- c. Connections between members, and connections between members and other construction;
- d. Location and size of openings which cut prestressing strands, or require the relocation of prestressing strands to be cast in the member;
- e. Headers for openings;
- f. Joints between members, and joints between members and other construction;
- g. Reinforcing, including prestressing steel details;
- h. Schedule and sequence of tensioning and detensioning prestressing strands;
- i. Material properties of steel and concrete used;
- j. Lifting and erection inserts;
- k. Dimensions and surface finishes of each member;
- l. Estimated camber;
- m. Erection sequence and handling requirements;
- n. All loads used in design (such as live, dead, handling, and erection);
- o. Bracing/shoring required; and
- p. Areas to receive toppings, topping thickness.
- q. Cross-section, and edge details.

- r. Layout, dimensions, and identification of each panel, corresponding to installation sequence.
- s. Setting drawings, instructions, and directions for installation of concrete inserts.
- t. Location and details of anchorage devices and lifting devices embedded in panels, and connection details to building

#### SD-01 Data

Precast Prestressed Concrete Design Calculations; GA.  
Concrete Mix Design; GA.  
Concrete Mix Design for Repair of Surface Defects; GA.  
Precast Concrete Wall Panel Connection and Embedment Design Calculations; GA.

Submit calculations reflecting design in accordance with the paragraph entitled "Precast Prestressed Concrete Member Design." Design calculations and drawings of prestressed members (including connections) shall be prepared and sealed by a registered professional engineer demonstrating compliance with indicated loading conditions, and submitted for approval prior to fabrication. Submit calculations for volume change as part of the design calculations.

Thirty days minimum prior to concrete placement, submit a mix design for each strength and type of concrete. Include a complete list of materials including type; brand; source and amount of cement, pozzolan, and admixtures; and applicable reference specifications.

#### SD-06 Instructions

Installation of Prestressed Concrete Members; GA.

Include precast concrete wall panel manufacturer's written recommendations for installation.

#### SD-08 Statements

Quality Control Procedures; FIO.

Submit quality control procedures established in accordance with PCI MNL-116 by the prestressing manufacturer.

#### SD-09 Reports

Fly Ash Test; FIO.  
Pozzolan Test; FIO.  
Ground Slag Test; FIO.  
Contractor-Furnished Mix Design; GA.  
Strength Tests; FIO.

Submit results of fly ash, pozzolan, and ground slag chemical and physical analysis performed within 6 months of submittal date. Provide copies of test reports showing that the mix has been successfully tested to produce

concrete with the properties specified and will be suitable for the job conditions. Obtain approval before concrete placement.

Submit copies of test reports showing that the mix has been successfully tested to produce concrete with the properties specified and will be suitable for the job conditions. Obtain approval before concrete placement.

Submit commercial testing results in accordance with PCI MNL-116 and as required in paragraph entitled "Sampling and Testing."

#### SD-14 Samples

Surface Finish; FIO.

Submit two 300 by 300 by 50 mm thick sample panels representative of the color and finish for each type of precast member to illustrate quality, color, and texture of both exposed-to-view surface finish and finish of panel surfaces that will be concealed by other construction.

#### SD-18 Records

Concrete Batch Ticket Information; FIO.

Submit mandatory batch ticket information for each load of ready-mixed concrete.

### 1.4 QUALITY CONTROL

#### 1.4.1 Precast Prestressed Concrete Member Design

ACI 318M and the PCI MNL-120. Design prestressed members (including connections) for the design load conditions and spans indicated, and for additional loads imposed by openings and supports of the work of other trades. Design prestressed members for handling without cracking in accordance with the PCI MNL-120. Prestressed members shall have a fire rating of 2 hours in accordance with UL FRD Fire Resistance Directory, or as designed in accordance with PCI MNL-124. Concrete toppings shall be used in establishing the design strength of the prestressed members.

#### 1.4.2 PCI Quality Certifications

Plants shall be certified by the PCI Plant Certification Program for Category C3 or C4 work.

##### 1.4.2.1 Product Quality Control

PCI MNL-116, at the prestressor's option, in lieu of core samples, ACI 318M full scale load tests may be performed. Perform on randomly selected members, as directed by the Contracting Officer.

### 1.5 DELIVERY, STORAGE, AND HANDLING

Lift and support prestressed members at the lifting and supporting points indicated on the detail drawings. Store prestressed members off the ground. Separate stacked prestressed members by battens across the full width of each bearing point. Protect from weather, marring, damage, and overload.

## 1.6 FACTORY INSPECTION

At the option of the Contracting Officer, precast units shall be inspected by the QC Representative prior to being transported to the job site. The Contractor shall give notice 14 days prior to the time the units will be available for plant inspection. Neither the exercise nor waiver of inspection at the plant will affect the Government's right to enforce contractual provisions after units are transported or erected.

## 2 PRODUCTS

### 2.1 CONCRETE

ACI 318M, for contractor furnished mix design. The minimum compressive strength of concrete at 28 days shall be 35 MPa, unless otherwise indicated. Add air-entraining admixtures at the mixer to produce between 4 and 6 percent air by volume.

### 2.2 MATERIALS

#### 2.2.1 Cement

ASTM C 150, Type I, II, or III; or ASTM C 595M Type IP(MS) or IS(MS) blended cement, except as modified herein. The blended cement shall consist of a mixture of ASTM C 150 cement and one of the following materials: ASTM C 618 pozzolan or fly ash, or ASTM C 989 ground iron blast furnace slag. The pozzolan/fly ash content shall not exceed 25 percent by weight of the total cementitious material. For exposed concrete, use one manufacturer for each type of cement, ground slag, fly ash, and pozzolan.

##### 2.2.1.1 Fly Ash and Pozzolan

ASTM C 618, Type N, F, or C, except that the maximum allowable loss on ignition shall be 6 percent for Type N and F.

##### 2.2.1.2 Ground Iron Blast-Furnace Slag

ASTM C 989, Grade 100 or 120.

#### 2.2.2 Water

Water shall be fresh, clean, and potable.

#### 2.2.3 Aggregates

##### 2.2.3.1 Grading and Composition

ASTM C 33, Size 67 or 7, except as modified herein. Obtain aggregates for exposed concrete surfaces from one source. The optional method of reducing the No. 50 and No. 100 sieve aggregates does not apply. Aggregates shall not contain any substance that may be deleteriously reactive with the alkalis in the cement. Aggregate shall not contain slag or crushed concrete.

##### 2.2.3.2 Aggregates for Lightweight Concrete

ASTM C 330.



#### 2.2.4 Grout

##### 2.2.4.1 Nonshrink Grout

ASTM C 1107.

##### 2.2.4.2 Cementitious Grout

Shall be a mixture of portland cement, sand, and water. Proportion one part cement to approximately 2.5 parts sand, with the amount of water based on placement method. Provide air entrainment for grout exposed to the weather.

#### 2.2.5 Admixtures

##### 2.2.5.1 Air-Entraining

ASTM C 260.

##### 2.2.5.2 Accelerating

ASTM C 494, Type C or E.

##### 2.2.5.3 Water Reducing

ASTM C 494, Types A, E, or F.

#### 2.2.6 Reinforcement

##### 2.2.6.1 Reinforcing Bars

ASTM A 706/A 706M, Grade 400; ASTM A 615/A 615M, Grade 400; ASTM A 617/A 617M, Grade 400; or ASTM A 616/A 616M, Grade 400.

##### 2.2.6.2 Welded Wire Fabric

ASTM A 185 or ASTM A 497.

##### 2.2.6.3 Spiral Wire

ASTM A 82.

##### 2.2.6.4 Supports for Concrete Reinforcement

Include bolsters, chairs, spacers, and other devices necessary for proper spacing, supporting, and fastening in place.

- a. Supports: ASTM A 615/A 615M, wire-type reinforcing bars and welded wire fabric.
- b. Legs of supports in contact with formwork: Stainless steel, ASTM A 167, Type 302 or Type 304.

##### 2.2.6.5 Prestressing Strands

- a. Seven Wire Stressed Relieved: ASTM A 416/A 416M for low relaxation wire.

- b. Single Wire Stressed Relieved: ASTM A 421 for low relaxation wire.

#### 2.2.7 Metal Accessories

Provide ASTM A 123 or ASTM A 153/A 153M galvanized.

##### 2.2.7.1 Inserts

###### 2.2.7.1.1 Threaded-Type Concrete Inserts

ASTM A 47M, Grade 22010, or may be medium strength cast steel conforming to ASTM A 27/A 27M, Grade 415-205. Provide galvanized ferrous casting having enlarged base with two nailing lugs minimum length less than the thickness of panel less 20 mm, and internally threaded to receive 20 mm diameter machine bolt. Ferrous castings shall be ferritic malleable iron.

###### 2.2.7.1.2 Wedge-Type Concrete Inserts

Provide galvanized, box-type ferrous castings with integral anchor loop at back of box to accept 20 mm diameter bolts having special wedge-shaped head. Provide ferrous castings ASTM A 47M, Grade 22010, ferritic malleable iron or ASTM A 27/A 27M, Grade 415-205,, medium-strength cast steel.

###### 2.2.7.1.3 Slotted-Type Concrete Inserts

Provide pressed steel plate, welded construction, box type with slot to receive 20 mm square head bolt, and provide lateral adjustment of bolt. Length of insert body, less anchorage lugs, shall be 110 mm minimum. Provide insert with knockout cover. Steel plate shall be 3 mm minimum thickness, ASTM A 283/A 283M, Grade C.

##### 2.2.7.2 Structural Steel

ASTM A 36/A 36M.

###### 2.2.7.2.1 Embedded Plates and Clip Angles

ASTM A 36/A 36M, galvanized, ferrous metal plate connectors for attachment to the structural framing using manufacturer standard construction procedures. Headed studs shall use 400 MPa steel with construction conforming to AWS D1.1, Type B. Deformed bar anchors shall conform to ASTM A 496.

##### 2.2.7.3 Bolts

ASTM A 307; ASTM A 325M.

##### 2.2.7.4 Nuts

ASTM A 563M. , Grade A, plain, square-type nuts where required for slotted-type concrete inserts.

##### 2.2.7.5 Washers

ASTM F 844 washers for ASTM A 307 bolts, and ASTM F 436M washers for ASTM A 325M bolts.

### 2.2.8 Form Materials

Provide forms and form-facing materials of wood, metal, plastic, or other approved material to produce concrete having the specified finish. Construct forms mortar-tight and of sufficient strength to withstand all pressures due to concrete placing operations and temperature changes within the specified fabrication tolerances.

### 2.2.9 Bearing Pads

#### 2.2.9.1 Elastomeric

AASHTO HB14, for plain neoprene bearings.

#### 2.2.9.2 Hardboard (Interior Only)

ANSI A135.4, class as specified by the prestressing manufacturer.

## 2.3 FABRICATION

PCI MNL-116, unless specified otherwise.

### 2.3.1 Forms

Brace forms to prevent deformation. Forms shall produce a smooth, dense surface. Chamfer exposed edges of columns and beams 20 mm, unless otherwise indicated. Provide threaded or snap-off type form ties.

### 2.3.2 Reinforcement Placement

ACI 318M for placement and splicing. Reinforcement may be preassembled before placement in forms. Provide exposed connecting bars, or other approved connection methods, between prestressed and cast-in-place construction. Remove any excess mortar that adheres to the exposed connections. Provide curvature or drape of the prestressing strands using approved hold-down devices.

### 2.3.3 Inserts

When the ends of the prestressed member will be exposed, recess the prestressing stands using inserts. After detensioning, remove inserts and fill the recess with nonshrink grout.

### 2.3.4 Concrete

#### 2.3.4.1 Concrete Mixing

ASTM C 94. Mixing operations shall produce batch-to-batch uniformity of strength, consistency, and appearance.

#### 2.3.4.2 Concrete Placing

ACI 304R, ACI 305R for hot weather concreting, ACI 306.1 for cold weather concreting, and ACI 309R, unless otherwise specified.

#### 2.3.4.3 Concrete Curing

Commence curing immediately following the initial set and completion of surface finishing. Provide curing procedures to keep the temperature of the concrete between 10 and 85 degrees C. When accelerated curing is used, apply heat at controlled rate and uniformly along the casting beds. Monitor temperatures at various points in a product line in different casts.

#### 2.3.5 Prestressing

Do not transfer prestressing forces during detensioning until the concrete has reached a minimum compressive strength of 24 MPa, unless a higher strength is required by the Contractor furnished design.

#### 2.3.6 Surface Finish

Repairs to honeycombed sections located in a bearing area shall be approved by the Contracting Officer prior to repairs. Prestressed members which contain honeycombed sections deep enough to expose prestressing strands shall be rejected. Prestressed members containing hairline cracks which are visible and are less than 0.5 mm in width, may be accepted except that cracks larger than 0.1 mm in width for surfaces exposed to the weather shall be repaired. However, prestressed members which contain cracks greater than 0.5 mm in width shall be approved by the Contracting Officer. When approved, the member shall be repaired. Any prestressed member that is structurally impaired shall be rejected.

##### 2.3.6.1 Unformed Surfaces

Provide a steel troweled finish.

##### 2.3.6.2 Formed Surfaces

PCI MNL-116 (Appendix A - Commentary), Chapter 3, for grades of surface finishes.

- a. Unexposed Surfaces: Provide a standard grade surface finish.
- b. Exposed Surfaces: Provide a standard grade surface finish. The combined area of acceptable defective areas shall not exceed 0.2 percent of the exposed to view surface area, and the patches shall be indistinguishable from the surrounding surfaces when dry.

### 3 EXECUTION

#### 3.1 SURFACE REPAIR

Prior to erection, and again after installation, check prestressed members for damage, such as cracking, spalling, and honeycombing. As directed by the Contracting Officer, prestressed members that do not meet the surface finish requirements specified in Part 2 in paragraph entitled "Surface Finish" shall be repaired, or removed and replaced with new prestressed members.

### 3.2 ERECTION

Erect prestressed members after the concrete has attained the specified compressive strength, unless otherwise approved by the prestressing manufacturer. In addition, prestressed members shall not be rigidly fixed in position until the prestressed member has "aged" 90 days after detensioning. Erect in accordance with the approved detail drawings. PCI MNL-116 and PCI MNL-120 (Chapter 8), for tolerances. Provide a 1:500 tolerance, if no tolerance is specified. Brace prestressed members, unless design calculations submitted with the detail drawings indicate bracing is not required. Follow the manufacturer's recommendations for maximum construction loads. Place prestressed members level, plumb, and square within tolerances. Align member ends.

### 3.3 BEARING SURFACES

Shall be flat, free of irregularities, and properly sized. Size bearing surfaces to provide for the indicated clearances between the prestressed member and adjacent prestressed members or adjoining field placed surfaces. Correct bearing surface irregularities with nonshrink grout. Provide bearing pads where indicated or required. Do not use hardboard bearing pads in exterior locations. Place prestressed members at right angles to the bearing surface, unless indicated otherwise, and draw-up tight without forcing or distortion, with sides plumb.

### 3.4 ANCHORAGE

Provide anchorage for fastening work in place. Conceal fasteners where practicable. Make threaded connections up tight and nick threads to prevent loosening.

### 3.5 WELDING

AWS D1.4 for welding connections and reinforcing splices. Do not weld prestressing strands. Protect the concrete and prestressing strands from heat during welding.

### 3.6 OPENINGS

Holes or cuts requiring prestressing steel to be cut, which are not indicated on the approved detail drawing, shall only be made with the approval of the Contracting Officer and the prestressing manufacturer. Drill holes less than 300 mm in diameter with a diamond tipped core drill.

### 3.7 GROUTING

Clean and fill indicated keyways between prestressed members, and other indicated areas, solidly with nonshrink grout or cementitious grout. Provide reinforcing where indicated. Remove excess grout before hardening.

### 3.8 SEALANTS

Provide as indicated and as specified in Section 07920, "Joint Sealants."

### 3.9 CONCRETE TOPPING

Provide as indicated and as specified in Section 03300, "Cast-In-Place Concrete."

### 3.10 SAMPLING AND TESTING

#### 3.10.1 Product Quality Control

PCI MNL-116 for PCI enrolled plants. Where panels are manufactured by specialists in plants not currently enrolled in the PCI "Quality Control Program," provide a product quality control system in accordance with PCI MNL-116 and perform concrete and aggregate quality control testing using an approved, independent commercial testing laboratory. Submit test results to the Contracting Officer.

##### 3.10.1.1 Aggregate Tests

ASTM C 33. Perform one test for each aggregate size, including determination of the specific gravity.

##### 3.10.1.2 Strength Tests

ASTM C 172. Provide ASTM C 39 and ASTM C 31 compression tests. Perform ASTM C 143 slump tests. Mold six cylinders each day or for every 15 cubic meters of concrete placed, whichever is greater. Perform strength tests using two cylinders at 7 days and two at 28 days. Cure four cylinders in the same manner as the panels and place at the point where the poorest curing conditions are offered. Moist cure two cylinders and test at 28 days.

##### 3.10.1.3 Changes in Proportions

If, the compressive strength falls below that specified, adjust the mix proportions and water content and make necessary changes in the temperature, moisture, and curing procedures to secure the specified strength. Notify the Contracting Officer of all changes.

##### 3.10.1.4 Strength Test Results

Evaluate compression test results at 28 days in accordance with ACI 214 using a coefficient of variation of 20 percent. Evaluate the strength of concrete by averaging the test results (two specimens) of standard cylinders tested at 28 days. Not more than 20 percent of the individual tests shall have an average compressive strength less than the specified ultimate compressive strength.

#### 3.10.2 Rejection

Panels in place may be rejected for any one of the following product defects or installation deficiencies remaining after repairs and cleaning have been accomplished. "Visible" means visible to a person with normal eyesight when viewed from a distance of 6 m in broad daylight.

- a. Nonconformance to specified tolerances.
- b. Air voids (bugholes or blowholes) larger than 10 mm diameter.

- c. Visible casting lines.
- d. Visible from joints.
- e. Visible irregularities.
- f. Visible stains on panel surfaces.
- g. Visible differences between panel and approved sample.
- h. Visible nonuniformity of textures or color.
- i. Visible areas of backup concrete bleeding through the facing concrete.
- j. Visible foreign material embedded in the face.
- k. Visible repairs.
- l. Visible reinforcement shadow lines.
- m. Visible cracks.

### 3.10.3 Field Quality Control

Perform field inspection of member connections. The Contracting Officer shall be notified in writing of defective welds, bolts, nuts and washers within 7 working days of the date of inspection. All defective connections or welds shall be removed and rewelded or repaired as required by the Contracting Officer.

#### 3.10.3.1 Welded Connection Visual Inspection

AWS D1.1, furnish the services of AWS-certified welding inspector for erection inspections. Welding inspector shall visually inspect all welds and identify all defective welds.

## SECTION 03512

## COMPOSITE STRUCTURAL CEMENTITIOUS WOOD FIBER ROOF DECK

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 1037 (1993) Evaluating Properties of Wood-Base  
Fiber and Particle Panel Materials

ASTM E 84 (1995a) Surface Burning Characteristics of  
Building Materials

## AMERICAN WELDING SOCIETY (AWS)

AWS D1.1 (1994) Structural Welding Code - Steel

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

## SD-01 Data

Composite Cementitious Wood Fiber Decking; GA.

Manufacturer's product literature, specifications, and current printed installation instructions on each item applicable to required work. Including published data, such as load tables, or certification, such as fire test results, that cementitious wood fiber roof decking complies with requirements and a descriptive list of materials.

## SD-04 Drawings

Composite Cementitious Wood Fiber Decking; GA.

Detail drawings showing roof decking installation, including framing at all openings for support of roof units. The detail drawings shall be accompanied by setting details, design calculations showing that the roof decking installation meets material and design requirements.

## SD-13 Certificates

Composite Cementitious Wood Fiber Decking; GA.

Certification, based on fire test results, substantiating that the decking furnished complies with fire rating requirements.



## SD-14 Samples

Composite Cementitious Wood Fiber Decking; GA.

Submit samples, each 600 mm long X width of panel, showing final range of texture and finish for decking, and conditions of edges and ends of panels.

## 1.3 GENERAL REQUIREMENTS

The Contractor shall furnish all design, labor, materials, accessories and equipment necessary to cover all areas shown on the drawings and specified herein with structural cementitious wood fiber roof deck panels so as to obtain a diaphragm design shear and support all applied loading. Structural cementitious wood fiber roof deck panels shall be the products of one manufacturer and shall be factory-produced items of a firm specializing in cementitious wood fiber roof decking. Structural cementitious wood fiber roof deck panels shall be composite panels consisting of a structural substrate, insulation board, and an OSB (oriented strand board) top surface, bonded together at the manufacturer's factory.

Design of the roof decking shall be performed by the Contractor for the load conditions (dead, live, uplift, and diaphragm shear loading) and spans indicated on the drawings and as specified herein and any additional load imposed by openings; work of other trades; and all loading and restraining conditions from fabrication, handling, and erection. Deflection shall not exceed  $L/360$  of span.

The work specified shall be performed by experienced, qualified installers. Equipment and ceiling shall be supported by structural framing and not directly from deck system. Deck system shall be classified as noncombustible by a nationally recognized testing laboratory.

## 1.4 DELIVERY AND STORAGE

Materials shall be delivered in original unopened, protective packages, containers, or bundles with the manufacturer's labels indicating brand name, deck style, size, and thickness legible and intact. Roof deck material shall be stored off the ground on a flat, level blocking 6" minimum raised platform and protected from weather, marring, damage, or overload. Materials shall be stored in original protective packaging to prevent soiling, physical damage, or wetting or other manner that prevents damage before use. Original packaging shall be open at each end to stabilize moisture content and temperature. Cover the bottom of stacks with moisture proof material and provide adequate ventilation air circulation under cover to prevent condensation. Decking must be protected from the weather with waterproof coverings. Plank shall be handled and stacked during storage and erection to avoid damage to face, ends and edges and shall be stored flat and off the ground and kept dry until used. CAUTION: Cementitious wood fiber roof decking must not be subjected to excess water.

## 2 PRODUCTS

### 2.1 COMPOSITE CEMENTITIOUS WOOD FIBER STRUCTURAL ROOF DECK

#### 2.1.1 General

Fabrication of roof deck units shall be under plant controlled conditions. Structural cementitious wood fiber roof decking shall be shaped under pressure to required dimensions from a mixture of wood fibers and cementitious materials in proportions to produce deck units meeting the loading and other design conditions specified herein and on the drawings. The Contractor shall coordinate the need for openings for mechanical and utility systems and for architectural purposes with the drawings. Any special shapes shall be fabricated as required. Exterior surfaces to receive subsequent application shall be suitable for the purpose intended and free of any coatings that would interfere with adhesion or bond.

The roof deck material shall have tongue and grooved and beveled edges on the longitudinal sides and square ends. Metal edge members, if furnished with units, shall be galvanized. All plank shall be long enough to span multiple (2 minimum) joist spacings except at the ends of runs. The roof deck material shall be uniformly thick with tolerance not to exceed plus or minus 3 mm and an approximate weight of 39 kg/sq. meter. Linear variation with change in moisture content, both linear and transverse, shall not be more than 0.2 percent when tested in accordance with ASTM D 1037.

Surfaces showing as exposed ceilings shall be an unpainted off white as manufactured or factory-primed painted to provide a light reflectance of 60 percent minimum as tested in accordance with ASTM C 523.

##### 2.1.1.1 Thermal, Fire and Vapor Transmission Requirements

The overall "R" value of the deck in place (including air films and roofing) shall be as shown.

The roof deck panels shall be a listed noncombustible component in a report from a nationally recognized testing laboratory, such as Underwriters Laboratories. The roof deck material shall be tested in accordance with ASTM E-84, and with a flame spread of less than 25 as to surface burning characteristics and smoke developed rating shall not exceed 150 when tested in accordance with ASTM E 84.

Deck composite assembly shall qualify as a vapor retarder and shall meet requirements of ASTM-C-578, Type I.

#### 2.1.2 Structural Design Requirements

Structural design of the roof decking shall be performed by the Contractor for the load conditions (dead, live, uplift, and diaphragm shear loading) and spans indicated on the drawings and as specified herein and any additional load imposed by openings; work of other trades; and all loading and restraining conditions from fabrication, handling, and erection. The Contractor should note that equipment and ceiling shall be supported by structural framing and not directly from deck system.

The roof deck system supplied shall be capable of supporting the loading specified herein and shown on the drawings. The roof deck system shall be

capable of developing a minimum diaphragm design shear of 5108 N/linear meter. The roof deck material shall be capable of supporting an average uniformly distributed total load of 1.7 kPa (1 kPa live load and 0.7 kPa dead load) minimum over recommended spans. The roof deck material shall be capable of developing a minimum resistance to wind uplift loading as shown on the drawings. In addition, the roof deck system (including standing seam metal roofing) shall conform to a published Underwriters Laboratories (U.L.) Class 90 wind uplift design. The roof deck shall have a deflection not to exceed  $L/360$  for the indicated spans.

#### 2.1.3 Composite Cementitious Wood Fiber Structural Roof Deck

The structural cementitious wood fiber roof deck panels shall be composite panels consisting of a structural substrate, insulation board, and an OSB top surface, bonded together at the manufacturer's factory.

##### 2.1.3.1 Structural Substrate

Bottom layer of composite assembly shall be structural cementitious wood fiber plank and shall be thickness as required by manufacturer to meet the required spans and indicated loading requirements.

##### 2.1.3.2 Foamed Plastic Insulation

Middle layer of composite assembly shall be a foamed plastic insulation and shall be MINIMUM 16 Kg/cubic meter density and shall be made without CFCs. The insulation shall have an ultimate aged metric "R" value no lower than 1.76/25 mm thickness. The material shall have a useful operating range of temperatures with an upper limit in excess of 100°C. Insulation shall have been tested in accordance with ASTM E-84 and found to have a flame spread of no more than 25, and smoke developed of no more than 200. Insulation shall be the thickness as shown. Insulation board shall meet the additional requirements as specified in Section 07412.

##### 2.1.3.3 Sheathing

Top layer of composite assembly shall be an A.P.A. rated 13 mm thick oriented strand board (OSB) sheathing.

#### 2.1.4 Anchorage

Fasteners shall be of steel, zinc-coated or equivalent protective metallic coatings. Adhesives, mastics, cements, tapes and primers shall be as recommended by the cementitious wood fiber plank manufacturer and shall be compatible with the material to which they are to be bonded.

##### 2.1.4.1 Clips

Clips, when required by manufacturer, used for the attachment of plank systems shall be min. 18 ga. galvanized steel type as recommended by plank manufacturer.

##### 2.1.4.2 Screws

Screws used for the direct attachment of plank systems to structural members shall be self-tapping metal screws with 38 mm washer, galvanized or coated for rustproofing in lengths long enough to penetrate 19 mm into the steel

joists or members. Screws shall be a minimum 25 mm longer than the thickness of the specified decking. Screws used for direct attachment to wood items shall be #14 minimum, 16 mm dia. head, galvanized. Screws shall be sized to penetrate and thread into steel a minimum of 38 mm. Washers for use with screws shall be F-100, 38 mm dia., 16 ga., galvanized countersunk washers.

#### 2.1.4.3 Nails

Nails for attachment of clips to panels (when required by the manufacturers standard connection system) shall be sized to penetrate deck units and clips at least 38 mm. Washers, when required for use with nails, shall be 38 mm dia. 16 ga. galvanized flat washers.

#### 2.1.4.4 Adhesives

Adhesives, where allowed, shall be a construction adhesive meeting American Plywood Association Standard No. AFG-01 and shall be of the type recommended for the material being attached and for the material to which the deck is being attached. Adhesives shall always be applied in a continuous 10 mm dia. bead.

#### 2.1.5 Miscellaneous Materials

Grout, if required and recommended by the manufacturer, to feather out irregularities in the deck surface, shall be Class B, premixed gypsum concrete.

### 2.2 ACCEPTABLE MANUFACTURERS

The following are acceptable manufacturers:

1. "Fibroplank/UN"; Martin Fireproofing Georgia, Inc., (706) 283-6942
2. Tectum "III"/Tectum "E"; Tectum Inc., Newark, Ohio 43055. (740) 345-9691

Alternate deck systems using a cementitious wood fiber roof deck may be submitted. Substitutions shall comply with all structural, acoustical, and insulating properties, and fire resistive properties, and general performance criteria listed below and shown on drawings. Surface of substitution shall be such that the roofing system can be attached to it without further preparation.

## 3 EXECUTION

### 3.1 COMPOSITE CEMENTITIOUS WOOD FIBER STRUCTURAL ROOF DECK INSTALLATION

#### 3.1.1 General

The work specified shall be performed by experienced, qualified installers. Installation shall be in accordance with the approved drawings. The Contractor should take steps to provide careful job coordination that will result in the simultaneous application of the roofing to ensure that roof deck is not exposed to precipitation or condensation which may cause water staining and reduce the structural strength of the deck with extended exposure. If job conditions do not permit prompt application of the roofing, the roof deck shall be protected from the weather. In most applications,

stripping the joints is recommended. Metal roofing shall be applied in accordance with roofing manufacturer's specifications.

Installation of equipment required by other trades shall be accomplished as the work progresses if required by the design. Field-cut openings for utility penetrations shall be accomplished in accordance with the manufacturer's recommendations. Roof deck shall be straight and true, and when laid in place must present a smooth, surface suitable for application of roofing. All roof decking units shall bear on at least two structural framing members with a 1 inch minimum bearing. Any cantilever plank shall not exceed the design span. Installation shall require a minimum of cutting. Cutting, where required, shall be at a true angle to the top of the unit. All units shall be made to fit around openings and projections, valleys, walls, and curbs, so that cut ends occur on supports and in a manner that will not damage the units. When roof deck units are connected to steel supports, any damaged galvanized coatings shall be cleaned and coated with zinc-rich paint. No attachment for carrying loads shall be made directly to the roof decking. Welding shall be in accordance with AWS D1.1. After installation is complete, the deck shall be left ready for the roofer. Gypsum concrete grout should be used to feather out any irregularities.

The roof deck erector shall inspect the structural steel support system before the start of this work so that any defects, deviations, or discrepancies in placement, spacing or alignment from the approved structural or fabricator's shop drawings. Any problems noted shall be rectified by the Contractor before the roof deck is installed.

When laying out deck panels, all personnel shall walk directly over structural supports until the deck has been securely attached. Avoid any unnecessary traffic on the deck. Where heavy objects are placed upon or transported over the deck or where material is repeatedly landed on the deck, temporary plank walkways or plywood platforms shall be used to distribute the weight and support the loads of such materials.

Roof deck panels shall be cut to fit neatly at walls or curbs and around other openings as shown on approved shop drawings. All ends, edges, perimeter edges, and cut edges shall be continuously supported by walls directly or other supplemental structural supports. Openings greater than 150 mm in any direction must have additional structural frame support and shall be framed by the steel erector or trade requiring the opening. Reinforcing channels should never be cut to make openings.

Deck System shall be laid with the tongue side leading (or groove side leading when clips are used to attach deck planks to structural members) and in accordance with the manufacturer's recommendations. Roof planks shall be laid directly on joists with square cut ends butted tightly together. End joints in alternate rows shall be staggered and must always fall over and be centered on supporting members. All joints shall be tightly butted. Where necessary, a driving block shall be used to ensure tight joints and prevent damage to the edges of the plank. The plank shall be supported on the ends and have a minimum bearing on joists of 25 mm.

The Contractor shall not install any deck panel that has a crack or break in the top or bottom surface. Likewise, do not rout or gouge-out the top or bottom surface for any reason. Oriented Strandboard is slippery when wet or dusty and special care should be exercised under these conditions.

### 3.1.2 Inspections

A special inspector shall be provided by the contractor if required by code since a diaphragm shear is specified. The special inspector shall be a qualified person who shall have demonstrated competence for the inspection of diaphragm construction procedures related to the roof deck attachment. He shall observe that the construction conforms to the design drawings and specifications. He shall provide a final inspection report to the Contracting Officer stating that the diaphragm fastening and installation was in conformance with the approved plans and specifications.

### 3.1.3 Fastening

The fastening system shall be as designed by the Contractor to achieve the structural capacities identified in the specifications and on the drawings and in accordance with the manufacturer's recommendations. Screws, nails, and welds sizes shall be as recommended by the manufacturer of the roof deck plank. Spacing and pattern shall be as per manufacturer's shop drawings. All deck planks shall be fastened to steel or structural supports through direct connections using screws or screwed or welded clips. Fasteners should be installed progressively as the deck is laid. **Adhesives shall not be used as means of attaching deck planks to structural supports.**

## 3.2 CLEANING AND PROTECTION

The installed decking units shall be protected from damage by weather and construction operations. The complete decking shall be kept clean and free of damaged or defaced units, and left ready to receive painting or roofing. Surfaces to be painted shall be dry and free of grease and oil. If the top surface is to left uncovered for a length of time in which it could be damaged by weather, the top surface shall receive a paint sealer as recommended by manufacturer. The installed roof decking units shall be protected from damage by weather and construction operations by a temporary cover until application of roofing.

## SECTION 04200

## MASONRY

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## ACI INTERNATIONAL (ACI)

ACI SP-66 (1994) ACI Detailing Manual

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 82	(1994) Steel Wire, Plain, for Concrete Reinforcement
ASTM A 153	(1996) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 615	(1995) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM C 55	(1995) Concrete Building Brick
ASTM C 67	(1994) Sampling and Testing Brick and Structural Clay Tile
ASTM C 90	(1995) Loadbearing Concrete Masonry Units
ASTM C 91	(1995) Masonry Cement
ASTM C 140	(1995a) Sampling and Testing Concrete Masonry Units
ASTM C 216	(1995) Facing Brick (Solid Masonry Units Made from Clay or Shale)
ASTM C 270	(1995) Mortar for Unit Masonry
ASTM C 476	(1991) Grout for Masonry
ASTM C 494	(1992) Chemical Admixtures for Concrete
ASTM C 578	(1992) Rigid, Cellular Polystyrene Thermal Insulation
ASTM C 641	(1982; R 1991) Staining Materials in Lightweight Concrete Aggregates
ASTM C 652	(1994) Hollow Brick (Hollow Masonry Units Made From Clay or Shale)

ASTM C 780	(1994) Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
ASTM C 1019	(1989a; R 1993) Sampling and Testing Grout
ASTM C 1072	(1994) Measurement of Masonry Flexural Bond Strength
ASTM C 1289	(1995) Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
ASTM D 2000	(1990; R 1994) Rubber Products in Automotive Applications
ASTM D 2240	(1991) Rubber Property - Durometer Hardness
ASTM D 2287	(1992) Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with SECTION 01330 SUBMITTAL PROCEDURES:

### SD-01 Data

Clay or Shale Brick; FIO. Concrete Brick; FIO. Insulation; FIO.

Manufacturer's descriptive data.

### SD-04 Drawings

Masonry Work; GA.

Drawings including plans, elevations, and details of wall reinforcement; details of reinforcing bars at corners and wall intersections; offsets; tops, bottoms, and ends of walls; control and expansion joints; and wall openings. Bar splice locations shall be shown. Bent bars shall be identified on a bending diagram and shall be referenced and located on the drawings. Wall dimensions, bar clearances, and wall openings greater than one masonry unit in area shall be shown. No approval will be given to the shop drawings until the Contractor certifies that all openings, including those for mechanical and electrical service, are shown. If, during construction, additional masonry openings are required, the approved shop drawings shall be resubmitted with the additional openings shown along with the proposed changes. Location of these additional openings shall be clearly highlighted. The minimum scale for wall elevations shall be 1 to 50. Reinforcement bending details shall conform to the requirements of ACI SP-66.



## SD-08 Statements

Cold Weather Installation; FIO.

Cold weather construction procedures.

## SD-09 Reports

Efflorescence Test; FIO. Field Testing of Mortar; FIO. Field Testing of Grout; FIO. Masonry Cement; FIO. Fire-rated CMU; FIO.

Test reports from an approved independent laboratory. Test reports on a previously tested material shall be certified as the same as that proposed for use in this project.

Special Inspection; FIO.

Copies of masonry inspector reports.

## SD-13 Certificates

Clay or Shale Brick; FIO. Concrete Brick; FIO. Concrete Masonry Units (CMU); FIO. Control Joint Keys; FIO. Anchors, Ties, and Bar Positioners; FIO. Expansion-Joint Materials; FIO. Joint Reinforcement; FIO. Reinforcing Steel Bars and Rods; FIO. Masonry Cement; FIO. Insulation; FIO. Precast Concrete Items; FIO. Mortar Admixtures; FIO. Grout Admixtures; FIO.

Certificates of compliance stating that the materials meet the specified requirements.

Insulation; FIO.

Certificate attesting that the polyurethane or polyisocyanurate insulation furnished for the project contains recovered material, and showing an estimated percent of such recovered material.

## SD-14 Samples

Concrete Masonry Units (CMU); GA. Concrete Brick; GA.  
Clay or Shale Brick; GA.

Color samples of three stretcher units and one unit for each type of special shape. Units shall show the full range of color and texture.

Anchors, Ties, and Bar Positioners; FIO.

Two of each type used.

Expansion-Joint Material; FIO.

One piece of each type used.

Joint Reinforcement; FIO.

One piece of each type used, including corner and wall intersection pieces, showing at least two cross wires.

Insulation; FIO.

One piece of board type insulation, not less than 400 mm by 600 mm in size, containing the label indicating the rated permeance and R-values.

Portable Panel; GA.

One panel of clay or shale brick, 600 mm by 600 mm, containing approximately 24 brick facings to establish range of color and texture.

### 1.3 SAMPLE MASONRY PANELS

After material samples are approved and prior to starting masonry work, sample masonry panels shall be constructed for each type and color of masonry required. At least 48 hours prior to constructing the sample panel or panels, the Contractor shall submit written notification to the Contracting Officer's Representative. Sample panels shall not be built in, or as part of the structure, but shall be located where directed.

#### 1.3.1 Configuration

Panels shall be L-shaped or otherwise configured to represent all of the wall elements. Panels shall be of the size necessary to demonstrate the acceptable level of workmanship for each type of masonry represented on the project. The minimum size of a straight panel or a leg of an L-shaped panel shall be 2.5 m by 1.2 m.

#### 1.3.2 Composition

Panels shall show full color range, texture, and bond pattern of the masonry work. The Contractor's method for mortar joint tooling; grouting of reinforced vertical cores, collar joints, bond beams, and lintels; positioning, securing, and lapping of reinforcing steel; positioning and lapping of joint reinforcement (including prefabricated corners); and cleaning of masonry work shall be demonstrated during the construction of the panels. Installation or application procedures for anchors, wall ties, glass block units, CMU control joints, brick expansion joints, insulation, flashing, brick soldier, row lock courses and weep holes shall be shown in the sample panels. The panels shall contain a masonry bonded corner that includes a bond beam corner. Panels shall show parging and installation of electrical boxes and conduit. Panels that represent reinforced masonry shall contain a 600 mm by 600 mm opening placed at least 600 mm above the panel base and 600 mm away from all free edges, corners, and control joints. Required reinforcing shall be provided around this opening as well as at wall corners and control joints.

#### 1.3.3 Construction Method

Where anchored veneer walls are required, the Contractor shall demonstrate and receive approval for the method of construction; i.e., either bring up the two wythes together or separately, with the insulation and appropriate ties placed within the specified tolerances across the cavity. Temporary provisions shall be demonstrated to preclude mortar or grout droppings in the cavity and to provide a clear open air space of the dimensions shown on the drawings. Where masonry is to be grouted, the Contractor shall demonstrate and receive approval on the method that will be used to bring up

the masonry wythes; support the reinforcing bars; and grout cells, bond beams, lintels, and collar joints using the requirements specified herein. If sealer is specified to be applied to the masonry units, sealer shall be applied to the sample panels. Panels shall be built on a properly designed concrete foundation.

#### 1.3.4 Usage

The completed panels shall be used as the standard of workmanship for the type of masonry represented. Masonry work shall not commence until the sample panel for that type of masonry construction has been completed and approved. Panels shall be protected from the weather and construction operations until the masonry work has been completed and approved. After completion of the work, the sample panels, including all foundation concrete, shall become the property of the Contractor and shall be removed from the construction site.

#### 1.4 DELIVERY, HANDLING, AND STORAGE

Materials shall be delivered, handled, stored, and protected to avoid chipping, breakage, and contact with soil or contaminating material.

##### 1.4.1 Masonry Units

Concrete masonry units shall be covered or protected from inclement weather and shall conform to the moisture content as specified in ASTM C 90 when delivered to the jobsite. In addition, glass block units and prefaced concrete units shall be stored with their finish surfaces covered. Prefabricated lintels shall be marked on top sides to show either the lintel schedule number or the number and size of top and bottom bars.

##### 1.4.2 Reinforcement, Anchors, and Ties

Steel reinforcing bars, coated anchors, ties, and joint reinforcement shall be stored above the ground. Steel reinforcing bars and uncoated ties shall be free of loose mill scale and rust.

##### 1.4.3 Cementitious Materials, Sand and Aggregates

Cementitious and other packaged materials shall be delivered in unopened containers, plainly marked and labeled with manufacturers' names and brands. Cementitious material shall be stored in dry, weathertight enclosures or be completely covered. Cement shall be handled in a manner that will prevent the inclusion of foreign materials and damage by water or dampness. Sand and aggregates shall be stored in a manner to prevent contamination or segregation.

#### 1.5 SPECIAL INSPECTION

A qualified masonry inspector approved by the Contracting Officer shall perform inspection of the masonry work. Minimum qualifications for the masonry inspector shall be 5 years of reinforced masonry inspection experience or acceptance by a State, municipality, or other governmental body having a program of examining and certifying inspectors for reinforced masonry construction. The masonry inspector shall be present during preparation of masonry prisms, sampling and placing of masonry units, placement of reinforcement (including placement of dowels in footings and

foundation walls), inspection of grout space, immediately prior to closing of cleanouts, and during grouting operations. The masonry inspector shall assure Contractor compliance with the drawings and specifications. The masonry inspector shall keep a complete record of all inspections and shall submit daily written reports to the Quality Control Supervisory Representative reporting the quality of masonry construction.

## 2 PRODUCTS

### 2.1 GENERAL REQUIREMENTS

The source of materials that will affect the appearance of the finished work shall not be changed after the work has started except with Contracting Officer's approval.

### 2.2 CLAY OR SHALE BRICK

Color range and texture of clay or shale brick shall be as indicated and shall conform to the approved sample. Grade SW shall be used for all brick. Brick shall be tested for efflorescence. Clay or shale brick units shall be delivered factory-blended to provide a uniform appearance and color range in the completed wall.

#### 2.2.1 Solid Clay or Shale Brick

Solid clay or shale shall conform to ASTM C 216, Type FBS. Brick size shall be modular and the nominal size of the brick used shall be 92.075 mm thick, 57.15 mm wide, and 193.675 mm long.

#### 2.2.2 Hollow Clay or Shale Brick

Hollow clay or shale brick shall conform to ASTM C 652, Type FBS. Brick size shall be modular and the nominal size of the brick used shall be 92.075 mm thick, 57.15 mm wide, and 193.675 mm long. Where vertical reinforcement is shown in hollow brick, the minimum cell dimension shall be 64 mm and the units shall be designed to provide precise vertical alignment of the cells.

### 2.3 CONCRETE BRICK

Concrete brick shall conform to ASTM C 55, Type I, Grade N. Concrete brick may be used where necessary for filling out in concrete masonry unit construction.

### 2.4 CONCRETE MASONRY UNITS (CMU)

Hollow and solid concrete masonry units shall conform to ASTM C 90, Type I, Lightweight. Cement shall have a low alkali content and be of one brand.

#### 2.4.1 Aggregates

Lightweight aggregates and blends of lightweight and heavier aggregates in proportions used in producing the units, shall comply with the following requirements when tested for stain-producing iron compounds in accordance with ASTM C 641: by visual classification method, the iron stain deposited on the filter paper shall not exceed the "light stain" classification.

## 2.4.2 Kinds and Shapes

Units shall be modular in size and shall include closer, jamb, header, lintel, and bond beam units and special shapes and sizes to complete the work as indicated. In exposed interior masonry surfaces, units having a bullnose shall be used for vertical external corners except at door, window, and louver jambs. Radius of the bullnose shall be 25 mm. Units used in exposed masonry surfaces in any one building shall have a uniform fine to medium texture and a uniform color.

## 2.4.2.1 Architectural Units

Units shall have patterned face shell. Face shell pattern shall be textured as shown. Units shall be integrally colored during manufacture. Color shall be as shown. Patterned face shell shall be properly aligned in the completed wall.

## 2.4.3 Fire-Rated CMU

Concrete masonry units used in fire-rated construction shown on the drawings shall be of minimum equivalent thickness for the fire rating indicated and the corresponding type of aggregates indicated in TABLE I. Units containing more than one of the aggregates listed in TABLE I will be rated on the aggregate requiring the greater minimum equivalent thickness to produce the required fire rating.

TABLE I

## FIRE-RATED CONCRETE MASONRY UNITS

See note (a) below

Aggregate Type	Minimum equivalent thickness in mm (inches) for fire rating of:		
	4 hours	3 hours	2 hours
Pumice	120 (4.7)	100 (4.0)	75 (3.0)
Expanded slag	130 (5.0)	110 (4.2)	85 (3.3)
Expanded clay, shale, or slate	145 (5.7)	120 (4.8)	95 (3.7)
Limestone, scoria, cinders or unexpanded slag	150 (5.9)	130 (5.0)	100 (4.0)
Calcareous gravel	160 (6.2)	135 (5.3)	105 (4.2)
Siliceous gravel	170 (6.7)	145 (5.7)	115 (4.5)

- (a) Minimum equivalent thickness shall equal net volume as determined in conformance with ASTM C 140 divided by the product of the actual length and height of the face shell of the unit in millimeters. Where walls are to receive plaster or be faced with brick, or otherwise form an assembly; the thickness of plaster or brick or

other material in the assembly will be included in determining the equivalent thickness.

## 2.5 PRECAST CONCRETE ITEMS

Trim, lintels, copings, splashblocks and door sills shall be factory-made units from a plant regularly engaged in producing precast concrete units. Unless otherwise indicated, concrete shall be 28 MPa minimum conforming to Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE using 13 mm to No. 4 nominal-size coarse aggregate, and minimum reinforcement shall be the reinforcement required for handling of the units. Clearance of 20 mm shall be maintained between reinforcement and faces of units. Unless precast-concrete items have been subjected during manufacture to saturated-steam pressure of at least 827 kPa for at least 5 hours, the items, after casting, shall be either damp-cured for 24 hours or steam-cured and shall then be aged under cover for 28 days or longer. Cast-concrete members weighing over 35 kg shall have built-in loops of galvanized wire or other approved provisions for lifting and anchoring. Units shall have beds and joints at right angles to the face, with sharp true arises and shall be cast with drip grooves on the underside where units overhang walls. Exposed-to-view surfaces shall be free of surface voids, spalls, cracks, and chipped or broken edges. Precast units exposed-to-view shall be of uniform appearance and color. Unless otherwise specified, units shall have a smooth dense finish. Prior to use, each item shall be wetted and inspected for crazing. Items showing evidence of dusting, spalling, crazing, or having surfaces treated with a protective coating will be rejected.

### 2.5.1 Lintels

Precast lintels, unless otherwise shown, shall be of a thickness equal to the wall and reinforced with two No. 4 bars for the full length. Top of lintels shall be labeled "TOP" or otherwise identified and each lintel shall be clearly marked to show location in the structure.

### 2.5.2 Sills and Copings

Sills and copings shall be cast with washes. Sills for windows having mullions shall be cast in sections with head joints at mullions and a 6 mm allowance for mortar joints. The ends of sills, except a 20 mm wide margin at exposed surfaces, shall be roughened for bond. Treads of door sills shall have rounded nosings.

### 2.5.3 Splash Blocks

Splash blocks shall be as detailed. Reinforcement shall be the manufacturer's standard.

## 2.6 MORTAR

Mortar shall be Type S in accordance with the proportion specification of ASTM C 270 except Type S cement-lime mortar proportions shall be 1 part cement, 1/2 part lime and 4-1/2 parts aggregate. When masonry cement ASTM C 91 is used, the maximum air content shall be limited to 12 percent and performance equal to cement-lime mortar shall be verified. Evaluation of performance shall be based on ASTM C 780 and ASTM C 1072. Mortar for prefaced concrete masonry unit wainscots shall contain aggregates with 100 percent passing the 2.36 mm sieve and 95 percent passing the 1.18 mm sieve.

Pointing mortar in showers and kitchens shall contain ammonium stearate, or aluminum tri-stearate, or calcium stearate in an amount equal to 3 percent by weight of cement used. Cement shall have a low alkali content and be of one brand. Aggregates shall be from one source.

#### 2.6.1 Admixtures

In cold weather, a non-chloride based accelerating admixture may be used subject to approval. Accelerating admixture shall be non-corrosive, shall contain less than 0.2 percent chlorides, and shall conform to ASTM C 494, Type C.

#### 2.6.2 Miscellaneous Masonry Accessories

##### 2.6.2.1 Wall Drainage System

High density Polyethylene or Nylon mesh in trapezoidal configuration designed to allow moisture to flow downward in the cavity or collar joint to masonry flashing and weeps and hence to the exterior. Drainage system to be continuous at the base of the wall.

Products: The Mortar Net TM, Mortar Net USA, Ltd. or approved equal.

Manufacturer's product codes:

MN10-1, MN10-08, MN10-04, MN16-1

25 mm thick x 254 mm high x 1 524 mm long (nominal sizes)

20 mm thick x 254 mm high x 1 524 mm long (nominal sizes)

10 mm thick x 254 mm high x 1 524 mm long (nominal sizes)

25 mm thick x 400 mm high x 1 524 mm long (nominal sizes)

##### 2.6.2.2 Prefabricated Inserts (for weep holes)

Prefabricated inserts for weep holes shall be equal to the following:

'Weep Vent', manufactured by Mortar Net USA, Ltd. or approved equal.

Vent shall be manufactured from 100% polyester and have 90% open mesh.

Color shall match mortar color.

#### 2.7 GROUT

Grout shall conform to ASTM C 476. Cement used in grout shall have a low alkali content. Grout slump shall be between 200 and 250 mm. Grout shall be used subject to the limitations of Table III. Proportions shall not be changed and materials with different physical or chemical characteristics shall not be used in grout for the work unless additional evidence is furnished that the grout meets the specified requirements.

##### 2.7.1 Admixtures

In cold weather, a non-chloride based accelerating admixture may be used subject to approval. Accelerating admixture shall be non-corrosive, shall contain less than 0.2 percent chlorides, and shall conform to ASTM C 494, Type C.

### 2.7.2 Grout Barriers

Grout barriers for vertical cores shall consist of fine mesh wire, fiberglass, or expanded metal.

## 2.8 ANCHORS, TIES, AND BAR POSITIONERS

Anchors and ties shall be fabricated without drips or crimps and shall be zinc-coated in accordance with ASTM A 153, Class B-2. Steel wire used for anchors and ties shall be fabricated from steel wire conforming to ASTM A 82. Anchors and ties shall be sized to provide a minimum of 16 mm mortar cover from either face.

### 2.8.1 Wire Mesh Ties

Wire mesh for tying 100 mm thick concrete masonry unit partitions to other intersecting masonry partitions shall be 13 mm mesh of minimum 16 gauge steel wire. Minimum lengths shall be not less than 300 mm.

### 2.8.2 Wall Ties

Wall ties shall be rectangular-shaped or Z-shaped fabricated of 5 mm diameter zinc-coated steel wire. Rectangular wall ties shall be no less than 100 mm wide. Wall ties may also be of a continuous type conforming to paragraph JOINT REINFORCEMENT. Adjustable type wall ties, if approved for use, shall consist of two essentially U-shaped elements fabricated of 5 mm diameter zinc-coated steel wire. Adjustable ties shall be of the double pintle to eye type and shall allow a maximum of 13 mm eccentricity between each element of the tie. Play between pintle and eye opening shall be not more than 2 mm. The pintle and eye elements shall be formed so that both can be in the same plane.

### 2.8.3 Dovetail Anchors

Dovetail anchors shall be of the flexible wire type, 5 mm diameter zinc-coated steel wire, triangular shaped, and attached to a 12 gauge or heavier steel dovetail section. These anchors shall be used for anchorage of veneer wythes or composite-wall facings extending over the face of concrete columns, beams, or walls. Cells within vertical planes of these anchors shall be filled solid with grout for full height of walls or partitions, or solid units may be used. Dovetail slots are specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE.

### 2.8.4 Adjustable Anchors

Adjustable anchors shall be 5 mm diameter steel wire, triangular-shaped. Anchors attached to steel shall be 8 mm diameter steel bars placed to provide 2 mm play between flexible anchors and structural steel members. Spacers shall be welded to rods and columns. Equivalent welded-on steel anchor rods or shapes standard with the flexible-anchor manufacturer may be furnished when approved. Welds shall be cleaned and given one coat of zinc-rich touch up paint.

### 2.8.5 Bar Positioners

Bar positioners, used to prevent displacement of reinforcing bars during the course of construction, shall be factory fabricated from 9 gauge steel wire



or equivalent, and coated with a hot-dip galvanized finish. Not more than one wire shall cross the cell.

## 2.9 JOINT REINFORCEMENT

Joint reinforcement shall be factory fabricated from steel wire conforming to ASTM A 82, welded construction. Tack welding will not be acceptable in reinforcement used for wall ties. Wire shall have zinc coating conforming to ASTM A 153, Class B-2. All wires shall be a minimum of 9 gauge. Reinforcement shall be ladder type design, having one longitudinal wire in the mortar bed of each face shell for hollow units and one wire for solid units. Joint reinforcement shall be placed a minimum of 16 mm cover from either face. The distance between crosswires shall not exceed 400 mm. Joint reinforcement for straight runs shall be furnished in flat sections not less than 3 m long. Joint reinforcement shall be provided with factory formed corners and intersections. If approved for use, joint reinforcement may be furnished with adjustable wall tie features.

## 2.10 REINFORCING STEEL BARS AND RODS

Reinforcing steel bars and rods shall conform to ASTM A 615, Grade 60.

## 2.11 CONTROL JOINT KEYS

Control joint keys shall be a factory fabricated solid section of natural or synthetic rubber (or combination thereof) conforming to ASTM D 2000 or polyvinyl chloride conforming to ASTM D 2287. The material shall be resistant to oils and solvents. The control joint key shall be provided with a solid shear section not less than 16 mm thick and 10 mm thick flanges, with a tolerance of plus or minus 2 mm. The control joint key shall fit neatly, but without forcing, in masonry unit jamb sash grooves. The control joint key shall be flexible at a temperature of minus 34 degrees C after five hours exposure, and shall have a durometer hardness of not less than 70 when tested in accordance with ASTM D 2240.

## 2.12 EXPANSION-JOINT MATERIALS

Backer rod and sealant shall be adequate to accommodate joint compression equal to 50 percent of the width of the joint. The backer rod shall be compressible rod stock of polyethylene foam, polyurethane foam, butyl rubber foam, or other flexible, nonabsorptive material as recommended by the sealant manufacturer. Sealant shall conform to Section 07920 JOINT SEALING.

## 2.13 INSULATION

### 2.13.1 Rigid Board-Type Insulation

Rigid board-type insulation shall be extruded polystyrene, polyurethane, or polyisocyanurate. Polystyrene shall conform to ASTM C 578. Polyurethane or polyisocyanurate shall conform to ASTM C 1289, Type I, Class 2, faced with aluminum foil on both sides of the foam. The insulation shall be a standard product and shall be marked with not less than the manufacturer's trademark or name, the specification number, the permeance and R-values.

#### 2.13.1.1 Insulation Thickness and Air Space

The cavity space shall allow for a maximum insulation thickness as shown, and a minimum air space of 20 mm.

#### 2.13.1.2 Aged R-Value

The insulation shall provide a minimum aged R-value of 0.88 (metric R). The aged R-value shall be determined at 24 degrees C in accordance with the appropriate referenced specification. The stated R-value of the insulation shall be certified by an independent testing laboratory or certified by an independent Registered Professional Engineer if tests are conducted in the manufacturer's laboratory.

#### 2.13.1.3 Recovered Material

Insulation shall contain the highest practicable percentage of recovered material derived from solid waste (but material reused in the manufacturing process cannot be counted toward the percentage of recovered material). Where two materials have the same price and performance, the one containing the higher recovered material content shall be provided. The polyurethane or polyisocyanurate foam shall have a minimum recovered material content of 9 percent by weight of the core material.

#### 2.13.2 Insulation Adhesive

Insulation adhesive shall be specifically prepared to adhere the insulation to the masonry and, where applicable, to the thru-wall flashing. The adhesive shall not deleteriously affect the insulation, and shall have a record of satisfactory and proven performance for the conditions under which to be used.

### 2.14 FLASHING

Flashing shall be as specified in Section 07600 SHEET METALWORK, GENERAL.

## 3 EXECUTION

### 3.1 ENVIRONMENTAL REQUIREMENTS

#### 3.1.1 Hot Weather Installation

The following precautions shall be taken if masonry is erected when the ambient air temperature is more than 37 degrees C in the shade and the relative humidity is less than 50 percent. All masonry materials shall be shaded from direct sunlight; mortar beds shall be spread no more than 1.2 m ahead of masonry; masonry units shall be set within one minute of spreading mortar; and after erection, masonry shall be protected from direct exposure to wind and sun for 48 hours.

#### 3.1.2 Cold Weather Installation

Before erecting masonry when ambient temperature or mean daily air temperature falls below 4 degrees C, a written statement of proposed cold weather construction procedures shall be submitted for approval. The following precautions shall be taken during all cold weather erection.

### 3.1.2.1 Preparation

Ice or snow formed on the masonry bed shall be thawed by the application of heat. Heat shall be applied carefully until the top surface of the masonry is dry to the touch. Sections of masonry deemed frozen and damaged shall be removed before continuing construction of those sections.

- a. Air Temperature 4 to 0 degrees C. Sand or mixing water shall be heated to produce mortar temperatures between 4 degrees C and 49 degrees C.
- b. Air Temperature 0 to minus 4 degrees C. Sand and mixing water shall be heated to produce mortar temperatures between 4 degrees C and 49 degrees C. Temperature of mortar on boards shall be maintained above freezing.
- c. Air Temperature minus 4 to minus 7 degrees C. Sand and mixing water shall be heated to provide mortar temperatures between 4 degrees C and 49 degrees C. Temperature of mortar on boards shall be maintained above freezing. Sources of heat shall be used on both sides of walls under construction. Windbreaks shall be employed when wind is in excess of 24 km/hour.
- d. Air Temperature minus 7 degrees C and below. Sand and mixing water shall be heated to provide mortar temperatures between 4 degrees C and 49 degrees C. Enclosure and auxiliary heat shall be provided to maintain air temperature above 0 degrees C. Temperature of units when laid shall not be less than minus 7 degrees C.

### 3.1.2.2 Completed Masonry and Masonry Not Being Worked On

- a. Mean daily air temperature 4 degrees C to 0 degrees C. Masonry shall be protected from rain or snow for 24 hours by covering with weather-resistive membrane.
- b. Mean daily air temperature 0 degrees C to minus 4 degrees C. Masonry shall be completely covered with weather-resistant membrane for 24 hours.
- c. Mean Daily Air Temperature minus 4 degrees C to minus 7 degrees C. Masonry shall be completely covered with insulating blankets or equally protected for 24 hours.
- d. Mean Daily Temperature minus 7 degrees C and Below. Masonry temperature shall be maintained above 0 degrees C for 24 hours by enclosure and supplementary heat, by electric heating blankets, infrared heat lamps, or other approved methods.

## 3.2 LAYING MASONRY UNITS

Masonry units shall be laid in running bond pattern, unless shown otherwise. Facing courses shall be level with back-up courses, unless the use of adjustable ties has been approved in which case the tolerances shall be plus or minus 13 mm. Each unit shall be adjusted to its final position while mortar is still soft and plastic. Units that have been disturbed after the mortar has stiffened shall be removed, cleaned, and re-laid with fresh mortar. Air spaces, cavities, chases, expansion joints, and spaces to be

grouted shall be kept free from mortar and other debris. Units used in exposed masonry surfaces shall be free from chipped edges or other imperfections detracting from the appearance of the finished work. Vertical joints shall be kept plumb. Units being laid and surfaces to receive units shall be free of water film and frost. Solid units shall be laid in a non-furrowed full bed of mortar. Mortar for veneer wythes shall be beveled and sloped toward the center of the wythe from the cavity side. Units shall be shoved into place so that the vertical joints are tight. Vertical joints of brick and the vertical face shells of concrete masonry units, except where indicated at control, expansion, and isolation joints, shall be completely filled with mortar. Mortar will be permitted to protrude up to 13 mm into the space or cells to be grouted. Means shall be provided to prevent mortar from dropping into the space below. In double wythe construction, the inner wythe may be brought up not more than 400 mm ahead of the outer wythe. Collar joints shall be filled with mortar or grout during the laying of the facing wythe, and filling shall not lag the laying of the facing wythe by more than 200 mm.

#### 3.2.1 Surface Preparation

Surfaces upon which masonry is placed shall be cleaned of laitance, dust, dirt, oil, organic matter, or other foreign materials and shall be slightly roughened to provide a surface texture with a depth of at least 3 mm. Sandblasting shall be used, if necessary, to remove laitance from pores and to expose the aggregate.

#### 3.2.2 Forms and Shores

Forms and shores shall be sufficiently rigid to prevent deflections which may result in cracking or other damage to supported masonry and sufficiently tight to prevent leakage of mortar and grout. Supporting forms and shores shall not be removed in less than 10 days.

#### 3.2.3 Concrete Masonry Units

Units in piers, pilasters, columns, starting courses on footings, solid foundation walls, lintels, and beams, and where cells are to be filled with grout shall be full bedded in mortar under both face shells and webs. Other units shall be full bedded under both face shells. Head joints shall be filled solidly with mortar for a distance in from the face of the unit not less than the thickness of the face shell. Foundation walls below grade shall be grouted solid. Jamb units shall be of the shapes and sizes to conform with wall units. Solid units may be incorporated in the masonry work where necessary to fill out at corners, gable slopes, and elsewhere as approved. Double walls shall be stiffened at wall-mounted plumbing fixtures by use of strap anchors, two above each fixture and two below each fixture, located to avoid pipe runs, and extending from center to center of the double wall. Walls and partitions shall be adequately reinforced for support of wall-hung plumbing fixtures when chair carriers are not specified.

#### 3.2.4 Clay or Shale Brick Units

Brick facing shall be laid with the better face exposed. Brick shall be laid in running bond with each course bonded at corners, unless otherwise indicated. Molded brick shall be laid with the frog side down. Brick that

is cored, recessed, or has other deformations may be used in sills, treads, soldier courses, except where deformations will be exposed to view.

#### 3.2.4.1 Wetting of Units

Wetting of clay, shale brick, or hollow brick units having an initial rate of absorption of more than 0.155 gm per minute per square cm (1 gm per minute per square inch) of bed surface shall be in conformance with ASTM C 67. The method of wetting shall ensure that each unit is nearly saturated but surface dry when laid.

#### 3.2.4.2 Solid Units

Bed, head, and collar joints shall be completely filled with mortar.

#### 3.2.4.3 Hollow Units

Hollow units shall be laid as specified for concrete masonry units.

#### 3.2.5 Tolerances

Masonry shall be laid plumb, true to line, with courses level. Bond pattern shall be kept plumb throughout. Corners shall be square unless noted otherwise. Except for walls constructed of prefaced concrete masonry units, masonry shall be laid within the following tolerances (plus or minus unless otherwise noted):

TABLE II

#### TOLERANCES

Variation from the plumb in the lines  
and surfaces of columns, walls and arises

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In adjacent masonry units	3 mm
In 3 m	6 mm
In 6 m	10 mm
In 12 m or more	13 mm

Variations from the plumb for external corners,  
expansion joints, and other conspicuous lines

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In 6 m	6 mm
In 12 m or more	13 mm

Variations from the level for exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines

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In 6 m	6 mm
In 12 m or more	13 mm

Variation from level for bed joints and top surfaces of bearing walls

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In 3 m	6 mm
In 12 m or more	13 mm

Variations from horizontal lines

---

In 3 m	6 mm
In 6 m	10 mm
In 12 m or more	13 mm

Variations in cross sectional dimensions of columns and in thickness of walls

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Minus	6 mm
Plus	13 mm

### 3.2.6 Cutting and Fitting

Full units of the proper size shall be used wherever possible, in lieu of cut units. Cutting and fitting, including that required to accommodate the work of others, shall be done by masonry mechanics using power masonry saws. Concrete masonry units may be wet or dry cut. Wet cut units, before being placed in the work, shall be dried to the same surface-dry appearance as uncut units being laid in the wall. Cut edges shall be clean, true and sharp. Openings in the masonry shall be made carefully so that wall plates, cover plates or escutcheons required by the installation will completely conceal the openings and will have bottoms parallel with the masonry bed joints. Reinforced masonry lintels shall be provided above openings over 300 mm wide for pipes, ducts, cable trays, and other wall penetrations, unless steel sleeves are used.

### 3.2.7 Jointing

Joints shall be tooled when the mortar is thumbprint hard. Horizontal joints shall be tooled last. Joints shall be brushed to remove all loose and excess mortar. Mortar joints shall be finished as follows:

#### 3.2.7.1 Flush Joints

Joints in concealed masonry surfaces and joints at electrical outlet boxes in wet areas shall be flush cut. Flush cut joints shall be made by cutting off the mortar flush with the face of the wall. Joints in unparged masonry walls below grade shall be pointed tight. Flush joints for architectural units, such as fluted units, shall completely fill both the head and bed joints.

#### 3.2.7.2 Tooled Joints

Joints in exposed exterior and interior masonry surfaces shall be tooled slightly concave. Joints shall be tooled with a jointer slightly larger than the joint width so that complete contact is made along the edges of the unit. Tooling shall be performed so that the mortar is compressed and the joint surface is sealed. Jointer of sufficient length shall be used to obtain a straight and true mortar joint.

#### 3.2.7.3 Door and Window Frame Joints

On the exposed interior side of exterior frames, joints between frames and abutting masonry walls shall be raked to a depth of 10 mm. On the exterior side of exterior frames, joints between frames and abutting masonry walls shall be raked to a depth of 10 mm.

### 3.2.8 Joint Widths

Joint widths shall be as follows:

#### 3.2.8.1 Concrete Masonry Units

Concrete masonry units shall have 6 mm joints so that a 200 mm module can be achieved horizontally and vertically.

#### 3.2.8.2 Brick

Brick joint widths shall be 6 mm so that multiples of 100 mm modules can be achieved horizontally and vertically. Brick expansion joint widths shall be the same, except as shown.

#### 3.2.9 Embedded Items

Spaces around built-in items shall be filled with mortar. Openings around flush-mount electrical outlet boxes in wet locations shall be pointed with mortar. Anchors, ties, wall plugs, accessories, flashing, pipe sleeves and other items required to be built-in shall be embedded as the masonry work progresses. Anchors, ties and joint reinforcement shall be fully embedded in the mortar. Cells receiving anchor bolts and cells of the first course below bearing plates shall be filled with grout.

### 3.2.10 Unfinished Work

Unfinished work shall be stepped back for joining with new work. Toothing may be resorted to only when specifically approved. Loose mortar shall be removed and the exposed joints shall be thoroughly cleaned before laying new work.

### 3.2.11 Masonry Wall Intersections

Each course shall be masonry bonded at corners and elsewhere as shown. Masonry walls shall be anchored or tied together at corners and intersections with bond beam reinforcement and prefabricated corner or tee pieces of joint reinforcement as shown.

### 3.2.12 Partitions

Partitions shall be continuous from floor to underside of floor or roof deck where shown. Openings in firewalls around joists or other structural members shall be filled as indicated or approved. Where suspended ceilings on both sides of partitions are indicated, the partitions other than those shown to be continuous may be stopped approximately 100 mm above the ceiling level. An isolation joint shall be placed in the intersection between partitions and structural or exterior walls as shown. Interior partitions having 100 mm nominal thick units shall be tied to intersecting partitions of 100 mm units, 125 mm into partitions of 150 mm units, and 175 into partitions of 200 mm or thicker units. Cells within vertical plane of ties shall be filled solid with grout for full height of partition or solid masonry units may be used. Interior partitions having masonry walls over 100 mm thick shall be tied together with joint reinforcement. Partitions containing joint reinforcement shall be provided with prefabricated pieces at corners and intersections or partitions.

## 3.3 ANCHORED VENEER CONSTRUCTION

The inner and outer wythes shall be completely separated by a continuous airspace as shown on the drawings. Both the inner and the outer wythes shall be laid up together except when adjustable joint reinforcement assemblies are approved for use. When both wythes are not brought up together, through-wall flashings shall be protected from damage until they are fully enclosed in the wall. The airspace between the wythes shall be kept clear and free of mortar droppings by temporary wood strips laid on the wall ties and carefully lifted out before placing the next row of ties. A drainage material shall be placed behind the weep holes in the cavity to a minimum depth of 250 mm of drainage material to keep mortar droppings from plugging the weep holes.

## 3.4 WEEP HOLES

Weep holes shall be provided not more than 600 mm on centers in mortar joints of the exterior wythe above wall flashing, over foundations, bond beams, and any other horizontal interruptions of the cavity. Weep holes shall be formed by placing prefabricated inserts within the full head joint. Weep holes shall be kept free of mortar and other obstructions.



### 3.5 COMPOSITE WALLS

Masonry wythes shall be tied together with joint reinforcement or with unit wall ties. Facing shall be anchored to concrete backing with wire dovetail anchors set in slots built in the face of the concrete as specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. The facing wythe shall be anchored or tied to the backup at a maximum spacing of 400 mm on center vertically and 600 mm on center horizontally. Unit ties shall be spaced not over 600 mm on centers horizontally, in courses not over 400 mm apart vertically, staggered in alternate courses. Ties shall be laid not closer than 16 mm to either masonry face. Ties shall not extend through control joints. Collar joints between masonry facing and masonry backup shall be filled solidly with grout.

### 3.6 MORTAR

Mortar shall be mixed in a mechanically operated mortar mixer for at least 3 minutes, but not more than 5 minutes. Measurement of ingredients for mortar shall be by volume. Ingredients not in containers, such as sand, shall be accurately measured by the use of measuring boxes. Water shall be mixed with the dry ingredients in sufficient amount to provide a workable mixture which will adhere to the vertical surfaces of masonry units. Mortar that has stiffened because of loss of water through evaporation shall be re-tempered by adding water to restore the proper consistency and workability. Mortar that has reached its initial set or that has not been used within 2-1/2 hours after mixing shall be discarded.

### 3.7 REINFORCING STEEL

Reinforcement shall be cleaned of loose, flaky rust, scale, grease, mortar, grout, or other coating which might destroy or reduce its bond prior to placing grout. Bars with kinks or bends not shown on the drawings shall not be used. Reinforcement shall be placed prior to grouting. Unless otherwise indicated, vertical wall reinforcement shall extend to within 50 mm of tops of walls.

#### 3.7.1 Positioning Bars

Vertical bars shall be accurately placed within the cells at the positions indicated on the drawings. A minimum clearance of 13 mm shall be maintained between the bars and masonry units. Minimum clearance between parallel bars shall be one diameter of the reinforcement. Vertical reinforcing may be held in place using bar positioners located near the ends of each bar and at intermediate intervals of not more than 192 diameters of the reinforcement. Column and pilaster ties shall be wired in position around the vertical steel. Ties shall be in contact with the vertical reinforcement and shall not be placed in horizontal bed joints.

#### 3.7.2 Splices

Bars shall be lapped a minimum of 48 diameters of the reinforcement. Welded or mechanical connections shall develop at least 125 percent of the specified yield strength of the reinforcement.

### 3.8 JOINT REINFORCEMENT

Joint reinforcement shall be installed at 400 mm on center or as indicated. Reinforcement shall be lapped not less than 150 mm. Prefabricated sections shall be installed at corners and wall intersections. The longitudinal wires of joint reinforcement shall be placed to provide not less than 16 mm cover to either face of the unit.

### 3.9 PLACING GROUT

Cells containing reinforcing bars shall be filled with grout. Hollow masonry units in walls or partitions supporting plumbing, heating, or other mechanical fixtures, voids at door and window jambs, and other indicated spaces shall be filled solid with grout. Cells under lintel bearings on each side of openings shall be filled solid with grout for full height of openings. Walls below grade, lintels, and bond beams shall be filled solid with grout. Units other than open end units may require grouting each course to preclude voids in the units. Grout not in place within 1-1/2 hours after water is first added to the batch shall be discarded. Sufficient time shall be allowed between grout lifts to preclude displacement or cracking of face shells of masonry units. If blowouts, flowouts, misalignment, or cracking of face shells should occur during construction, the wall shall be torn down and rebuilt.

#### 3.9.1 Vertical Grout Barriers for Fully Grouted Walls

Grout barriers shall be provided not more than 10 m apart, or as required, to limit the horizontal flow of grout for each pour.

#### 3.9.2 Horizontal Grout Barriers

Grout barriers shall be embedded in mortar below cells of hollow units receiving grout.

#### 3.9.3 Grout Holes and Cleanouts

##### 3.9.3.1 Grout Holes

Grouting holes shall be provided in slabs, spandrel beams, and other in-place overhead construction. Holes shall be located over vertical reinforcing bars or as required to facilitate grout fill in bond beams. Additional openings spaced not more than 400 mm on centers shall be provided where grouting of all hollow unit masonry is indicated. Openings shall not be less than 100 mm in diameter or 75 by 100 mm in horizontal dimensions. Upon completion of grouting operations, grouting holes shall be plugged and finished to match surrounding surfaces.

##### 3.9.3.2 Cleanouts for Hollow Unit Masonry Construction

Cleanout holes shall be provided at the bottom of every pour in cores containing vertical reinforcement when the height of the grout pour exceeds 1.5 m. Where all cells are to be grouted, cleanout courses shall be constructed using bond beam units in an inverted position to permit cleaning of all cells. Cleanout holes shall be provided at a maximum spacing of 800 mm where all cells are to be filled with grout. A new series of cleanouts shall be established if grouting operations are stopped for more than 4 hours. Cleanouts shall not be less than 75 by 100 mm openings cut from one

face shell. Manufacturer's standard cutout units may be used at the Contractor's option. Cleanout holes shall not be closed until masonry work, reinforcement, and final cleaning of the grout spaces have been completed and inspected. For walls which will be exposed to view, cleanout holes shall be closed in an approved manner to match surrounding masonry.

#### 3.9.3.3 Cleanouts for Solid Unit Masonry Construction

Cleanouts for construction of walls consisting of a grout filled cavity between solid masonry wythes shall be provided at the bottom of every pour by omitting every other masonry unit from one wythe. A new series of cleanouts shall be established if grouting operations are stopped for more than 4 hours. Cleanout holes shall not be plugged until masonry work, reinforcement, and final cleaning of the grout spaces have been completed and inspected. For walls which will be exposed to view, cleanout holes shall be closed in an approved manner to match surrounding masonry.

#### 3.9.4 Grouting Equipment

##### 3.9.4.1 Grout Pumps

Pumping through aluminum tubes will not be permitted. Pumps shall be operated to produce a continuous stream of grout without air pockets, segregation, or contamination. Upon completion of each day's pumping, waste materials and debris shall be removed from the equipment, and disposed of outside the masonry.

##### 3.9.4.2 Vibrators

Internal vibrators shall maintain a speed of not less than 5,000 impulses per minute when submerged in the grout. At least one spare vibrator shall be maintained at the site at all times. Vibrators shall be applied at uniformly spaced points not further apart than the visible effectiveness of the machine. Duration of vibration shall be limited to time necessary to produce satisfactory consolidation without causing segregation.

#### 3.9.5 Grout Placement

Masonry shall be laid to the top of a pour before placing grout. Grout shall not be placed in two-wythe solid unit masonry cavity until mortar joints have set for at least 3 days during hot weather and 5 days during cold damp weather. Grout shall not be placed in hollow unit masonry until mortar joints have set for at least 24 hours. Grout shall be placed using a hand bucket, concrete hopper, or grout pump to completely fill the grout spaces without segregation of the aggregates. Vibrators shall not be inserted into lower pours that are in a semi-solidified state. The height of grout pours and type of grout used shall be limited by the dimensions of grout spaces as indicated in Table III. Low-lift grout methods may be used on pours up to and including 1.5 m in height. High-lift grout methods shall be used on pours exceeding 1.5 m in height.

##### 3.9.5.1 Low-Lift Method

Grout shall be placed at a rate that will not cause displacement of the masonry due to hydrostatic pressure of the grout. Mortar protruding more than 13 mm into the grout space shall be removed before beginning the grouting operation. Grout pours 300 mm or less in height shall be

consolidated by mechanical vibration or by puddling. Grout pours over 300 mm in height shall be consolidated by mechanical vibration and reconsolidated by mechanical vibration after initial water loss and settlement has occurred. Vibrators shall not be inserted into lower pours that are in a semi-solidified state. Low-lift grout shall be used subject to the limitations of Table III.

### 3.9.5.2 High-Lift Method

Mortar droppings shall be cleaned from the bottom of the grout space and from reinforcing steel. Mortar protruding more than 6 mm into the grout space shall be removed by dislodging the projections with a rod or stick as the work progresses. Reinforcing, bolts, and embedded connections shall be rigidly held in position before grouting is started. CMU units shall not be pre-wetted. Grout, from the mixer to the point of deposit in the grout space shall be placed as rapidly as practical by pumping and placing methods which will prevent segregation of the mix and cause a minimum of grout splatter on reinforcing and masonry surfaces not being immediately encased in the grout lift. The individual lifts of grout shall be limited to 1.2 m in height. The first lift of grout shall be placed to a uniform height within the pour section and vibrated thoroughly to fill all voids. This first vibration shall follow immediately behind the pouring of the grout using an approved mechanical vibrator. After a waiting period sufficient to permit the grout to become plastic, but before it has taken any set, the succeeding lift shall be poured and vibrated 300 to 450 mm into the preceding lift. If the placing of the succeeding lift is going to be delayed beyond the period of workability of the preceding, each lift shall be reconsolidated by reworking with a second vibrator as soon as the grout has taken its settlement shrinkage. The waiting, pouring, and reconsolidation steps shall be repeated until the top of the pour is reached. The top lift shall be reconsolidated after the required waiting period. The high-lift grouting of any section of wall between vertical grout barriers shall be completed to the top of a pour in one working day unless a new series of cleanout holes is established and the resulting horizontal construction joint cleaned. High-lift grout shall be used subject to the limitations in Table III.

TABLE III

POUR HEIGHT AND TYPE OF GROUT FOR VARIOUS GROUT SPACE DIMENSIONS

Maximum Grout Pour Height (m)	(4)	Grout Type	Grouting Procedure	Minimum Dimensions of the Total Clear Areas Within Grout Spaces and Cells (mm) (1,2)	
				Multiwythe Masonry (3)	Hollow-unit Masonry
0.3		Fine	Low Lift	20	40 x 50
1.5		Fine	Low Lift	50	50 x 75
2.4		Fine	High Lift	50	50 x 75
3.6		Fine	High Lift	65	65 x 75
7.3		Fine	High Lift	75	75 x 75
0.3		Coarse	Low Lift	40	40 x 75
1.5		Coarse	Low Lift	50	65 x 75
2.4		Coarse	High Lift	50	75 x 75

3.6	Coarse	High Lift	65	75 x 75
7.3	Coarse	High Lift	75	75 x 100

## Notes:

- (1) The actual grout space or cell dimension must be larger than the sum of the following items:
  - a) The required minimum dimensions of total clear areas given in the table above;
  - b) The width of any mortar projections within the space;
  - c) The horizontal projections of the diameters of the horizontal reinforcing bars within a cross section of the grout space or cell.
- (2) The minimum dimensions of the total clear areas shall be made up of one or more open areas, with at least one area being 20 mm or greater in width.
- (3) For grouting spaces between masonry wythes.
- (4) Where only cells of hollow masonry units containing reinforcement are grouted, the maximum height of the pour shall not exceed the distance between horizontal bond beams.

## 3.10 BOND BEAMS

Bond beams shall be filled with grout and reinforced as indicated on the drawings. Grout barriers shall be installed under bond beam units to retain the grout as required. Reinforcement shall be continuous, including around corners, except through control joints or expansion joints, unless otherwise indicated on the drawings. Where splices are required for continuity, reinforcement shall be lapped 48 bar diameters. A minimum clearance of 13 mm shall be maintained between reinforcement and interior faces of units.

## 3.11 CONTROL JOINTS

Control joints shall be provided as indicated and shall be constructed in accordance with the details shown on the drawings. Sash jamb units shall have a 19 by 19 mm groove near the center at end of each unit. The vertical mortar joint at control joint locations shall be continuous, including through all bond beams. This shall be accomplished by utilizing half blocks in alternating courses on each side of the joint. The control joint key shall be interrupted in courses containing continuous bond beam steel. In single wythe exterior masonry walls, the exterior control joints shall be raked to a depth of 20 mm; backer rod and sealant shall be installed in accordance with Section 07920 JOINT SEALING. Exposed interior control joints shall be raked to a depth of 6 mm. Concealed control joints shall be flush cut.

## 3.12 BRICK EXPANSION JOINTS AND CONCRETE MASONRY VENEER JOINTS

Brick expansion joints and concrete masonry veneer joints shall be provided and constructed as shown on the drawings. Joints shall be kept free of mortar and other debris.

### 3.13 SHELF ANGLES

Shelf angles shall be adjusted as required to keep the masonry level and at the proper elevation. Shelf angles shall be galvanized. Shelf angles shall be provided in sections not longer than 3 m and installed with a 6 mm gap between sections. Shelf angles shall be mitered and welded at building corners with each angle not shorter than 1.2 m, unless limited by wall configuration.

### 3.14 LINTELS

#### 3.14.1 Masonry Lintels

Masonry lintels shall be constructed with lintel units filled solid with grout in all courses and reinforced with a minimum of two No. 4 bars in the bottom course unless otherwise indicated on the drawings. Lintel reinforcement shall extend beyond each side of masonry opening 40 bar diameters or 600 mm, whichever is greater. Reinforcing bars shall be supported in place prior to grouting and shall be located 15 mm above the bottom inside surface of the lintel unit.

#### 3.14.2 Precast Concrete and Steel Lintels

Precast concrete and steel lintels shall be as shown on the drawings. Lintels shall be set in a full bed of mortar with faces plumb and true. Steel and precast lintels shall have a minimum bearing length of 200 mm unless otherwise indicated on the drawings.

### 3.15 SILLS AND COPINGS

Sills and copings shall be set in a full bed of mortar with faces plumb and true.

### 3.16 ANCHORAGE TO CONCRETE AND STRUCTURAL STEEL

#### 3.16.1 Anchorage to Concrete

Anchorage of masonry to the face of concrete columns, beams, or walls shall be with dovetail anchors spaced not over 400 mm on centers vertically and 600 mm on center horizontally.

#### 3.16.2 Anchorage to Structural Steel

Masonry shall be anchored to vertical structural steel framing with adjustable steel wire anchors spaced not over 400 mm on centers vertically, and if applicable, not over 600 mm on centers horizontally.

### 3.17 PARGING

The outside face of below-grade exterior concrete-masonry unit walls enclosing usable rooms and spaces, except crawl spaces, shall be parged with type S mortar. Parging shall not be less than 13 mm thick troweled to a smooth dense surface so as to provide a continuous unbroken shield from top of footings to a line 150 mm below adjacent finish grade, unless otherwise indicated. Parging shall be coved at junction of wall and footing. Parging shall be damp-cured for 48 hours or more before backfilling. Parging shall be protected from freezing temperatures until hardened.

### 3.18 INSULATION

Anchored veneer walls shall be insulated, where shown, by installing board-type insulation on the cavity side of the inner wythe. Board type insulation shall be applied directly to the masonry or thru-wall flashing with adhesive. Insulation shall be neatly fitted between obstructions without impaling of insulation on ties or anchors. The insulation shall be applied in parallel courses with vertical joints breaking midway over the course below and shall be applied in moderate contact with adjoining units without forcing, and shall be cut to fit neatly against adjoining surfaces.

### 3.19 SPLASH BLOCKS

Splash blocks shall be located as shown.

### 3.20 POINTING AND CLEANING

After mortar joints have attained their initial set, but prior to hardening, mortar and grout daubs or splashings shall be completely removed from masonry-unit surfaces that will be exposed or painted. Before completion of the work, defects in joints of masonry to be exposed or painted shall be raked out as necessary, filled with mortar, and tooled to match existing joints. Immediately after grout work is completed, scum and stains which have percolated through the masonry work shall be removed using a high pressure stream of water and a stiff bristled brush. Masonry surfaces shall not be cleaned, other than removing excess surface mortar, until mortar in joints has hardened. Masonry surfaces shall be left clean, free of mortar daubs, dirt, stain, and discoloration, including scum from cleaning operations, and with tight mortar joints throughout. Metal tools and metal brushes shall not be used for cleaning.

#### 3.20.1 Concrete Masonry Unit and Concrete Brick Surfaces

Exposed concrete masonry unit and concrete brick surfaces shall be dry-brushed at the end of each day's work and after any required pointing, using stiff-fiber bristled brushes.

#### 3.20.2 Clay or Shale Brick Surfaces

Exposed clay or shale brick masonry surfaces shall be cleaned as necessary to obtain surfaces free of stain, dirt, mortar and grout daubs, efflorescence, and discoloration or scum from cleaning operations. After cleaning, the sample panel of similar material shall be examined for discoloration or stain as a result of cleaning. If the sample panel is discolored or stained, the method of cleaning shall be changed to assure that the masonry surfaces in the structure will not be adversely affected. The exposed masonry surfaces shall be water-soaked and then cleaned with a solution proportioned 30 milliliters trisodium phosphate and 30 milliliters laundry detergent to 1 liter of water or cleaned with a proprietary masonry cleaning agent specifically recommended for the color and texture by the clay products manufacturer. The solution shall be applied with stiff fiber brushes, followed immediately by thorough rinsing with clean water. Proprietary cleaning agents shall be used in conformance with the cleaning product manufacturer's printed recommendations. Efflorescence shall be removed in conformance with the brick manufacturer's recommendations.

### 3.21 BEARING PLATES

Bearing plates for beams, joists, joist girders and similar structural members shall be set to the proper line and elevation with damp-pack bedding mortar, except where non-shrink grout is indicated. Bedding mortar and non-shrink grout shall be as specified in Section 03300CAST-IN-PLACE STRUCTURAL CONCRETE.

### 3.22 PROTECTION

Facing materials shall be protected against staining. Top of walls shall be covered with nonstaining waterproof covering or membrane when work is not in progress. Covering of the top of the unfinished walls shall continue until the wall is waterproofed with a complete roof or parapet system. Covering shall extend a minimum of 600 mm down on each side of the wall and shall be held securely in place. Before starting or resuming, top surface of masonry in place shall be cleaned of loose mortar and foreign material.

### 3.23 TEST REPORTS

#### 3.23.1 Field Testing of Mortar

At least three specimens of mortar shall be taken each day. A layer of mortar 13 to 16 mm thick shall be spread on the masonry units and allowed to stand for one minute. The specimens shall then be prepared and tested for compressive strength in accordance with ASTM C 780.

#### 3.23.2 Field Testing of Grout

Field sampling and testing of grout shall be in accordance with the applicable provisions of ASTM C 1019. A minimum of three specimens of grout per day shall be sampled and tested. Each specimen shall have a minimum ultimate compressive strength of 13.8 MPa at 28 days.

#### 3.23.3 Efflorescence Test

Brick which will be exposed to weathering shall be tested for efflorescence. Tests shall be scheduled far enough in advance of starting masonry work to permit retesting if necessary. Sampling and testing shall conform to the applicable provisions of ASTM C 67. Units meeting the definition of "effloresced" will be subjected to rejection.



## SECTION 05055

## WELDING, STRUCTURAL

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC-04 (1989) Specification for Structural Steel Buildings - Allowable Stress Design, Plastic Design

## AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

ASNT-01 (1996) Recommended Practice SNT-TC-1A

## AMERICAN WELDING SOCIETY (AWS)

AWS A2.4 (1993) Standard Symbols for Welding, Brazing and Nondestructive Examination

AWS A3.0 (1994) Standard Welding Terms and Definitions

AWS D1.1 (1994) Structural Welding Code - Steel

AWS Z49.1 (1994) Safety in Welding and Cutting and Allied Processes

## 1.2 DEFINITIONS

Definitions of welding terms shall be in accordance with AWS A3.0.

## 1.3 GENERAL REQUIREMENTS

The design of welded connections shall conform to AISC-04 unless otherwise indicated or specified. Material with welds will not be accepted unless the welding is specified or indicated on the drawings or otherwise approved. Welding shall be as specified in this section, except where additional requirements are shown on the drawings or are specified in other sections. Welding shall not be started until welding procedures, welders, welding operators, and tackers have been qualified and the submittals approved by the Contracting Officer. Qualification testing shall be performed at or near the work site. Each Contractor performing welding shall maintain records of the test results obtained in welding procedure, welder, welding operator, and tacker performance qualifications.

## 1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The

following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

SD-08 Statements

Welding Procedure Qualifications; FIO.

Welder, Welding Operator, and Tacker Qualification; FIO.

Inspector Qualification; FIO.

Copies of the welding procedure specifications; the procedure qualification test records; and the welder, welding operator, or tacker qualification test records.

SD-18 Records

Quality Control; FIO.

A quality assurance plan and records of tests and inspections.

1.5 WELDING PROCEDURE QUALIFICATIONS

Except for prequalified (per AWS D1.1) and previously qualified procedures, each Contractor performing welding shall record in detail and shall qualify the welding procedure specification for any welding procedure followed in the fabrication of weldments. Qualification of welding procedures shall conform to AWS D1.1 and to the specifications in this section. Copies of the welding procedure specification and the results of the procedure qualification test for each type of welding which requires procedure qualification shall be submitted for approval. Approval of any procedure, however, will not relieve the Contractor of the sole responsibility for producing a finished structure meeting all the requirements of these specifications. This information shall be submitted on the forms in Appendix E of AWS D1.1. Welding procedure specifications shall be individually identified and shall be referenced on the detail drawings and erection drawings, or shall be suitably keyed to the contract drawings. In case of conflict between this specification and AWS D1.1, this specification governs.

1.5.1 Previous Qualifications

Welding procedures previously qualified by test may be accepted for this contract without requalification if the following conditions are met:

- a. Testing was performed by an approved testing laboratory, technical consultant, or the Contractor's approved quality control organization.
- b. The qualified welding procedure conforms to the requirements of this specification and is applicable to welding conditions encountered under this contract.
- c. The welder, welding operator, and tacker qualification tests conform to the requirements of this specification and are applicable to welding conditions encountered under this contract.

### 1.5.2 Prequalified Procedures

Welding procedures which are considered prequalified as specified in AWS D1.1 will be accepted without further qualification. The Contractor shall submit for approval a listing or an annotated drawing to indicate the joints not prequalified. Procedure qualification shall be required for these joints.

### 1.5.3 Retests

If welding procedure fails to meet the requirements of AWS D1.1, the procedure specification shall be revised and requalified, or at the Contractor's option, welding procedure may be retested in accordance with AWS D1.1. If the welding procedure is qualified through retesting, all test results, including those of test welds that failed to meet the requirements, shall be submitted with the welding procedure.

## 1.6 WELDER, WELDING OPERATOR, AND TACKER QUALIFICATION

Each welder, welding operator, and tacker assigned to work on this contract shall be qualified in accordance with the applicable requirements of AWS D1.1 and as specified in this section. Welders, welding operators, and tackers who make acceptable procedure qualification test welds will be considered qualified for the welding procedure used.

### 1.6.1 Previous Qualifications

At the discretion of the Contracting Officer, welders, welding operators, and tackers qualified by test within the previous 6 months may be accepted for this contract without requalification if all the following conditions are met:

- a. Copies of the welding procedure specifications, the procedure qualification test records, and the welder, welding operator, and tacker qualification test records are submitted and approved in accordance with the specified requirements for detail drawings.
- b. Testing was performed by an approved testing laboratory, technical consultant, or the Contractor's approved quality control organization.
- c. The previously qualified welding procedure conforms to the requirements of this specification and is applicable to welding conditions encountered under this contract.
- d. The welder, welding operator, and tacker qualification tests conform to the requirements of this specification and are applicable to welding conditions encountered under this contract.

### 1.6.2 Certificates

Before assigning any welder, welding operator, or tacker to work under this contract, the Contractor shall submit the names of the welders, welding operators, and tackers to be employed, and certification that each individual is qualified as specified. The certification shall state the type of welding and positions for which the welder, welding operator, or tacker is qualified, the code and procedure under which the individual is

qualified, the date qualified, and the name of the firm and person certifying the qualification tests. The certification shall be kept on file, and 3 copies shall be furnished. The certification shall be kept current for the duration of the contract.

#### 1.6.3 Renewal of Qualification

Requalification of a welder or welding operator shall be required under any of the following conditions:

- a. It has been more than 6 months since the welder or welding operator has used the specific welding process for which he is qualified.
- b. There is specific reason to question the welder or welding operator's ability to make welds that meet the requirements of these specifications.
- c. The welder or welding operator was qualified by an employer other than those firms performing work under this contract, and a qualification test has not been taken within the past 12 months. Records showing periods of employment, name of employer where welder, or welding operator, was last employed, and the process for which qualified shall be submitted as evidence of conformance.
- d. A tacker who passes the qualification test shall be considered eligible to perform tack welding indefinitely in the positions and with the processes for which he is qualified, unless there is some specific reason to question the tacker's ability. In such a case, the tacker shall be required to pass the prescribed tack welding test.

#### 1.7 INSPECTOR QUALIFICATION

Inspection and nondestructive testing personnel shall be qualified in accordance with the requirements of ASNT-01 for Levels I or II in the applicable nondestructive testing method. The inspector may be supported by assistant welding inspectors who are not qualified to ASNT-01, and assistant inspectors may perform specific inspection functions under the supervision of the qualified inspector.

#### 1.8 SYMBOLS

Symbols shall be in accordance with AWS A2.4, unless otherwise indicated.

#### 1.9 SAFETY

Safety precautions during welding shall conform to AWS Z49.1.

### 2 PRODUCTS

#### 2.1 WELDING EQUIPMENT AND MATERIALS

All welding equipment, electrodes, welding wire, and fluxes shall be capable of producing satisfactory welds when used by a qualified welder or welding operator performing qualified welding procedures. All welding equipment and materials shall comply with the applicable requirements of AWS D1.1.

### 3 EXECUTION

#### 3.1 WELDING OPERATIONS

##### 3.1.1 Requirements

Workmanship and techniques for welded construction shall conform to the requirements of AWS D1.1 and AISC-04. When AWS D1.1 and the AISC-04 specification conflict, the requirements of AWS D1.1 shall govern.

##### 3.1.2 Identification

Welds shall be identified in one of the following ways:

- a. Written records shall be submitted to indicate the location of welds made by each welder, welding operator, or tacker.
- b. Each welder, welding operator, or tacker shall be assigned a number, letter, or symbol to identify welds made by that individual. The Contracting Officer may require welders, welding operators, and tackers to apply their symbol next to the weld by means of rubber stamp, felt-tipped marker with waterproof ink, or other methods that do not cause an indentation in the metal. For seam welds, the identification mark shall be adjacent to the weld at 1 meter intervals. Identification with die stamps or electric etchers shall not be allowed.

#### 3.2 QUALITY CONTROL

Testing shall be done by an approved inspection or testing laboratory or technical consultant, or if approved, the Contractor's inspection and testing personnel may be used instead of the commercial inspection or testing laboratory or technical consultant. The Contractor shall perform visual inspection to determine conformance with paragraph STANDARDS OF ACCEPTANCE. Procedures and techniques for inspection shall be in accordance with applicable requirements of AWS D1.1, except that in radiographic inspection only film types designated as "fine grain," or "extra fine," shall be employed.

#### 3.3 STANDARDS OF ACCEPTANCE

Dimensional tolerances for welded construction, details of welds, and quality of welds shall be in accordance with the applicable requirements of AWS D1.1 and the contract drawings. Nondestructive testing shall be by visual inspection methods. The minimum extent of nondestructive testing shall be random [\_\_\_\_\_] percent of welds or joints, as indicated on the drawings.

##### 3.3.1 Nondestructive Examination

The welding shall be subject to inspection and tests in the mill, shop, and field. Inspection and tests in the mill or shop will not relieve the Contractor of the responsibility to furnish weldments of satisfactory quality. When materials or workmanship do not conform to the specification requirements, the Government reserves the right to reject material or workmanship or both at any time before final acceptance of the structure containing the weldment.

### 3.4 GOVERNMENT INSPECTION AND TESTING

In addition to the inspection and tests performed by the Contractor for quality control, the Government will perform inspection and testing for acceptance to the extent determined by the Contracting Officer. The costs of such inspection and testing will be borne by the Contractor if unsatisfactory welds are discovered, or by the Government if the welds are satisfactory. The work may be performed by the Government's own forces or under a separate contract for inspection and testing. The Government reserves the right to perform supplemental nondestructive and destructive tests to determine compliance with paragraph STANDARDS OF ACCEPTANCE.

### 3.5 CORRECTIONS AND REPAIRS

When inspection or testing indicates defects in the weld joints, the welds shall be repaired using a qualified welder or welding operator as applicable. Corrections shall be in accordance with the requirements of AWS D1.1 and the specifications. Defects shall be repaired in accordance with the approved procedures. Defects discovered between passes shall be repaired before additional weld material is deposited. Wherever a defect is removed and repair by welding is not required, the affected area shall be blended into the surrounding surface to eliminate sharp notches, crevices, or corners. After a defect is thought to have been removed, and before rewelding, the area shall be examined by suitable methods to insure that the defect has been eliminated. Repair welds shall meet the inspection requirements for the original welds. Any indication of a defect shall be regarded as a defect, unless reevaluation by nondestructive methods or by surface conditioning shows that no unacceptable defect is present.

## SECTION 05120

## STRUCTURAL STEEL

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC ASD Manual	(1989) Manual of Steel Construction Allowable Stress Design
AISC LRFD Vol II	(1995) Manual of Steel Construction Load & Resistance Factor Design, Vol II: Structural Members, Specifications & Codes

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 6/A 6M	(1996b) General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A 36/A 36M	(1996) Carbon Structural Steel
ASTM A 53	(1996) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 307	(1994) Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 325M	(1993) High-Strength Bolts for Structural Steel Joints (Metric)
ASTM A 500	(1993) Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A 563M	(1993) Carbon and Alloy Steel Nuts (Metric)
ASTM A 572/A 572M	(1994c) High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM F 436M	(1993) Hardened Steel Washers (Metric)
ASTM F 844	(1990) Washers, Steel, Plain (Flat), Unhardened for General Use
ASTM F 959	(1996) Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners

## AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.21.1 (1994) Lock Washers (Inch Series)

ASME B46.1 (1995) Surface Texture (Surface Roughness, Waviness, and Lay)

## AMERICAN WELDING SOCIETY (AWS)

AWS A2.4 (1993) Standard Symbols for Welding, Brazing and Nondestructive Examination

AWS D1.1 (1996) Structural Welding Code - Steel

## STEEL STRUCTURES PAINTING COUNCIL (SSPC)

SSPC Paint 25 (1991) Red Iron Oxide, Zinc Oxide, Raw Linseed Oil and Alkyd Primer (without Lead and Chromate Pigments)

## 1.2 GENERAL REQUIREMENTS

Structural steel fabrication and erection shall be performed by an organization experienced in structural steel work of equivalent magnitude. The Contractor shall be responsible for correctness of detailing, fabrication, and for the correct fitting of structural members. Connections, for any part of the structure not shown on the contract drawings, shall be considered simple shear connections and shall be designed and detailed in accordance with pertinent provisions of AISC ASD Manual and AISC LRFD Vol II. Substitution of sections or modification of connection details will not be accepted unless approved by the Contracting Officer. AISC ASD Manual and AISC ASD/LRFD Vol shall govern the work. Welding shall be in accordance with AWS D1.1. High-strength bolting shall be in accordance with AISC ASD Manual.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

## SD-04 Drawings

Structural Steel System; GA. Structural Connections; GA.

Shop and erection details including members (with their connections) not shown on the contract drawings. Welds shall be indicated by standard welding symbols in accordance with AWS A2.4.



## SD-08 Statements

Erection; FIO.

Prior to erection, erection plan of the structural steel framing describing all necessary temporary supports, including the sequence of installation and removal.

## SD-13 Certificates

Mill Test Reports; FIO.

Certified copies of mill test reports for structural steel, structural bolts, nuts, washers and other related structural steel items, including attesting that the structural steel furnished contains no less than 25 percent recycled scrap steel and meets the requirements specified herein, prior to the installation.

Welder Qualifications; FIO.

Certified copies of welder qualifications test records showing qualification in accordance with AWS D1.1.

Fabrication; FIO.

A copy of the AISC certificate indicating that the fabrication plant meets the specified structural steelwork category.

## SD-14 Samples

High Strength Bolts and Nuts; FIO. Carbon Steel Bolts and Nuts; FIO. Nuts Dimensional Style; FIO. Washers; FIO.

Random samples of bolts, nuts, and washers as delivered to the job site if requested, taken in the presence of the Contracting Officer and provided to the Contracting Officer for testing to establish compliance with specified requirements.

## 1.4 STORAGE

Material shall be stored out of contact with the ground in such manner and location as will minimize deterioration.

## 2 PRODUCTS

## 2.1 STRUCTURAL STEEL

## 2.1.1 Carbon Grade Steel

Carbon grade steel shall conform to ASTM A 36/A 36M (250 Mpa).

## 2.1.2 High-Strength Low-Alloy Steel

High-strength low-alloy steel shall conform to ASTM A 572/A 572M, Grade 50 (345 Mpa).

## 2.2 STRUCTURAL TUBING

Structural tubing shall conform to ASTM A 500, Grade B.

## 2.3 STEEL PIPE

Steel pipe shall conform to ASTM A 53, Type E or Type S, Grade B.

## 2.4 HIGH STRENGTH BOLTS AND NUTS

High strength bolts shall conform to ASTM A 325M , Type 1 with carbon steel nuts conforming to ASTM A 563M , Grade C. All structural steel bolting shall utilize high strength bolts.

## 2.5 CARBON STEEL BOLTS AND NUTS

Carbon steel bolts shall conform to ASTM A 307, Grade A with carbon steel nuts conforming to ASTM A 563M , Grade A.

## 2.6 NUTS DIMENSIONAL STYLE

Carbon steel nuts shall be Hex style when used with ASTM A 307 bolts or Heavy Hex style when used with ASTM A 325M bolts.

## 2.7 WASHERS

Plain washers shall conform to ASTM F 844. Other types, when required, shall conform to ASME B18.21.1, ASTM F 436M, or ASTM F 959.

## 2.8 PAINT

Paint shall conform to SSPC Paint 25.

# 3 EXECUTION

## 3.1 FABRICATION

Fabrication shall be in accordance with the applicable provisions of AISC ASD Manual. Fabrication and assembly shall be done in the shop to the greatest extent possible. The fabricating plant shall be certified under the AISC quality certification program for Category I structural steelwork. Compression joints depending on contact bearing shall have a surface roughness not in excess of 13 micrometer as determined by ASME B46.1, and ends shall be square within the tolerances for milled ends specified in ASTM A 6/A 6M. Structural steelwork, except surfaces of steel to be encased in concrete, surfaces to be field welded, surfaces to be fireproofed, and contact surfaces of friction-type high-strength bolted connections shall be prepared for painting in accordance with AISC ASD Manual and primed with the specified paint.

## 3.2 ERECTION

Erection of structural steel shall be in accordance with the applicable provisions of AISC ASD Manual.

### 3.2.1 Structural Connections

Anchor bolts and other connections between the structural steel and foundations shall be provided and shall be properly located and built into connecting work. Field welded structural connections shall be completed before load is applied.

### 3.2.2 Base Plates and Bearing Plates

Column base plates for columns and bearing plates for beams, girders, and similar members shall be provided. Base plates and bearing plates shall be provided with full bearing after the supported members have been plumbed and properly positioned, but prior to placing superimposed loads. Separate setting plates under column base plates will not be permitted. The area under the plate shall be damp-packed solidly with bedding mortar, except where nonshrink grout is indicated on the drawings. Bedding mortar and grout shall be as specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE.

### 3.2.3 Field Priming

After erection, the field bolt heads and nuts, field welds, and any abrasions in the shop coat shall be cleaned and primed with paint of the same quality as that used for the shop coat.

## SECTION 05210

## STEEL JOISTS

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## STEEL JOIST INSTITUTE (SJI)

SJI-01 (1994) Standard Specifications Load Tables and Weight Tables for Steel Joists and Joist Girders

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

## SD-04 Drawings

Steel Joists; GA.

Detail drawings shall include fabrication and erection details, specifications for shop painting, and identification markings of joists.

## SD-13 Certificates

Steel Joists; GA.

Certificates stating that the steel joists have been designed and manufactured in accordance with SJI-01. Complete engineering design computations may be submitted in lieu of the certification.

## 1.3 DESCRIPTION

Steel joists are designated on the drawings in accordance with the standard designations of the Steel Joist Institute. Joists of other standard designations or joists with properties other than those shown may be substituted for the joists designated provided the structural properties are equal to or greater than those of the joists shown and provided all other specified requirements are met.

## 1.4 DELIVERY AND STORAGE

Materials shall be delivered to the site in undamaged condition and stored off the ground in a well drained location, protected from damage, and easily accessible for inspection and handling.

## 2 PRODUCTS

### 2.1 OPEN WEB STEEL JOISTS

Open web steel joists shall conform to SJI-01, K-Series. Joists shall be designed to support the loads given in the standard load tables of SJI-01.

### 2.2 ACCESSORIES AND FITTINGS

Accessories and fittings, including VS series joists, end supports, and bridging, shall be in accordance with the standard specifications under which the members were designed.

### 2.3 SHOP PAINTING

Joists and accessories shall be shop painted with a rust-inhibiting primer paint. For joists which will be finish painted under Section 09900 PAINTING, GENERAL, the primer paint shall be limited to a primer which is compatible with the specified finish paint.

## 3 EXECUTION

### 3.1 ERECTION

Installation of joists shall be in accordance with the standard specification under which the member was produced. Joists shall be handled in a manner to avoid damage. Damaged joists shall be removed from the site, except when field repair is approved and such repairs are satisfactorily made in accordance with the manufacturer's recommendations. Joists shall be accurately set, and end anchorage shall be in accordance with the standard specification under which the joists were produced. For spans over 12 m through 18 m one row of bridging nearest midspan shall be bolted diagonal bridging; for spans over 18 m bolted diagonal bridging shall be used instead of welded horizontal bridging. Joist bridging and anchoring shall be secured in place prior to the application of any construction loads. Any temporary loads shall be distributed so that the carrying capacity of any joist is not exceeded. Loads shall not be applied to bridging during construction or in the completed work. Abraded, corroded, and field welded areas shall be cleaned and touched up with the same type of paint used in the shop painting.

### 3.2 BEARING PLATES

Bearing plates shall be provided with full bearing after the supporting members have been plumbed and properly positioned, but prior to placing superimposed loads. The area under the plate shall be damp-packed solidly with bedding mortar, except where nonshrink grout is indicated on the drawings. Bedding mortar and grout shall be as specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE.

## SECTION 05300

## STEEL DECKING

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI-01 (1986; Addenda 1989) Cold-Formed Steel Design Manual

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 611 (1994) Steel, Sheet, Carbon, Cold-Rolled, Structural Quality

ASTM A 653 (1995) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy coated (Galvannealed) by the Hot-Dip Process

ASTM A 780 (1993a) Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings

ASTM A 792 (1995) Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process, General Requirements

## AMERICAN WELDING SOCIETY (AWS)

AWS D1.3 (1989) Structural Welding Code - Sheet Steel

## STEEL DECK INSTITUTE (SDI)

SDI-02 (1987; Amended 1991) Diaphragm Design Manual

SDI Pub No 28 (1995) Design Manual for Composite Decks, Form Decks, Roof Decks, and Cellular Metal Floor Deck with Electrical Distribution

## STEEL STRUCTURES PAINTING COUNCIL (SSPC)

SSPC Paint 20 (1991) Zinc-Rich Primers (Type I - Inorganic and Type II - Organic)

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

## SD-01 Data

Deck Units; GA.

Design computations for the structural properties of the deck units or SDI certification that the units are designed in accordance with SDI specifications.

## SD-04 Drawings

Deck Units; GA. Accessories; GA.  
Attachments; GA. Holes and Openings; GA.

Drawings shall include type, configuration, structural properties, location, and necessary details of deck units, accessories, and supporting members; size and location of holes to be cut and reinforcement to be provided; location and sequence of welded or fastener connections; and the manufacturer's erection instructions.

## SD-13 Certificates

Deck Units; FIO. Attachments; FIO.

Manufacturer's certificates attesting that the decking material meets the specified requirements. Manufacturer's certificate attesting that the operators are authorized to use the low-velocity piston tool.

## SD-14 Samples

Deck Units; FIO. Accessories; FIO.

A 0.19 sq. meter sample of the decking material to be used, along with a sample of each of the accessories used. A sample of acoustical material to be used shall be included.

## SD-18 Statements

Attachments; FIO.

Prior to welding operations, copies of qualified procedures and lists of names and identification symbols of qualified welders and welding operators.

## 1.3 DELIVERY, STORAGE, AND HANDLING

Deck units shall be delivered to the site in a dry and undamaged condition, stored off the ground with one end elevated, and stored under a weathertight covering permitting good air circulation. Finish of deck units shall be maintained at all times by using touch-up paint whenever necessary to prevent the formation of rust.

## 2 PRODUCTS

## 2.1 DECK UNITS

Deck units shall conform to SDI Pub No 28. Panels of maximum possible lengths shall be used to minimize end laps. Fabricate deck units in lengths to span 3 or more supports with flush, telescoped, or nested 50 mm laps at

ends, and interlocking, or nested side laps, unless otherwise indicated. Deck with cross-sectional configuration differing from the units indicated may be used, provided that the properties of the proposed units, determined in accordance with AISI-01, are equal to or greater than the properties of the units indicated and that the material will fit the space provided without requiring revisions to adjacent materials or systems.

#### 2.1.1 Roof Deck

Steel deck used in conjunction with insulation and built-up roofing shall conform to ASTM A 653, ASTM A 611 or ASTM A 792. Roof deck units shall be fabricated of the steel design thickness required by the design drawings and shall be zinc-coated in conformance with ASTM A 653, G90 coating class or aluminum-zinc coated in accordance with ASTM A 792 Coating Designation AZ55.

#### 2.1.2 Form Deck

Deck used as a permanent form for concrete shall conform to ASTM A 653 or ASTM A 611. Deck used as a form for concrete shall be fabricated of the steel design thickness required by the design drawings, and shall be zinc-coated in conformance with ASTM A 653, G60 coating class.

### 2.2 TOUCH-UP PAINT

Touch-up paint for shop-painted units shall be of the same type used for the shop painting, and touch-up paint for zinc-coated units shall be an approved galvanizing repair paint with a high-zinc dust content. Welds shall be touched-up with paint conforming to SSPC Paint 20 in accordance with ASTM A 780. Finish of deck units and accessories shall be maintained by using touch-up paint whenever necessary to prevent the formation of rust.

### 2.3 ADJUSTING PLATES

Adjusting plates or segments of deck units shall be provided in locations too narrow to accommodate full-size units. As far as practical, the plates shall be the same thickness and configuration as the deck units.

### 2.4 CLOSURE PLATES

#### 2.4.1 Closure Plates for Roof Deck

Voids above interior walls shall be closed with sheet metal where shown. Open deck cells at parapets, end walls, eaves, and openings through roofs shall be closed with sheet metal. Sheet metal shall be same thickness as deck units.

##### 2.4.1.1 Cover Plates to Close Panels

Cover plates to close panel edge and end conditions and where panels change direction or abut. Butt joints in composite steel deck may receive a tape joint cover.

##### 2.4.1.2 Column Closures to Close Openings

Column closures to close openings between steel deck and structural steel columns.



#### 2.4.1.3 Sheet Metal

Where deck is cut for passage of pipes, ducts, columns, etc., and deck is to remain exposed, provide a neatly cut sheet metal collar to cover edges of deck. Do not cut deck until after installation of supplemental supports.

### 2.5 ACCESSORIES

The manufacturer's standard accessories shall be furnished as necessary to complete the deck installation. Metal accessories shall be of the same material as the deck and have minimum design thickness as follows: saddles, 1.204 mm; welding washers, 1.519 mm; cant strip, 0.749 mm; other metal accessories, 0.909 mm; unless otherwise indicated. Accessories shall include but not be limited to saddles, welding washers, cant strips, butt cover plates, underlapping sleeves, and ridge and valley plates.

## 3 EXECUTION

### 3.1 ERECTION

Erection of deck and accessories shall be in accordance with SDI Pub No 28 and SDI-02 and the approved detail drawings. Damaged deck and accessories including material which is permanently stained or contaminated, with burned holes or deformed shall not be installed. The deck units shall be placed on secure supports, properly adjusted, and aligned at right angles to supports before being permanently secured in place. The deck shall not be filled with concrete, used for storage or as a working platform until the units have been secured in position. Loads shall be distributed by appropriate means to prevent damage during construction and to the completed assembly. The maximum uniform distributed storage load shall not exceed the design live load. There shall be no loads suspended directly from the steel deck.

### 3.2 ATTACHMENTS

All fasteners shall be installed in accordance with the manufacturer's recommended procedure, except as otherwise specified. The deck units shall be welded with nominal 16 mm diameter puddle welds or fastened with screws, powder-actuated fasteners or pneumatically driven fasteners to supports as indicated on the design drawings and in accordance with requirements of SDI Pub No 28. All welding of steel deck shall be in accordance with AWS D1.3 using methods and electrodes as recommended by the manufacturer of the steel deck being used. Welds shall be made only by operators previously qualified by tests prescribed in AWS D1.3 to perform the type of work required. Welding washers shall be used at the connections of the deck to supports. Welding washers shall not be used at sidelaps. Holes and similar defects will not be acceptable. Deck ends shall be lapped 50 mm. All partial or segments of deck units shall be attached to structural supports in accordance with Section 2.5 of SDI-02. Powder-actuated fasteners shall be driven with a low-velocity piston tool by an operator authorized by the manufacturer of the piston tool. Pneumatically driven fasteners shall be driven with a low-velocity fastening tool and shall comply with the manufacturer's recommendations.

### 3.3 HOLES AND OPENINGS

All holes and openings required shall be coordinated with the drawings, specifications, and other trades. Holes and openings shall be drilled or

cut, reinforced and framed as indicated on the drawings or described in the specifications and as required for rigidity and load capacity. Holes and openings less than 150 mm across require no reinforcement. Holes and openings 150 to 300 mm across shall be reinforced by 1.204 mm thick steel sheet at least 300 mm wider and longer than the opening and be fastened to the steel deck at each corner of the sheet and at a maximum of 150 mm on center. Holes and openings larger than 300 mm shall be reinforced by steel angles installed perpendicular to the steel joists and supported by the adjacent steel joists. Steel angles shall be installed perpendicular to the deck ribs and shall be fastened to the angles perpendicular to the steel joists. Openings must not interfere with seismic members such as chords and drag struts.

#### 3.4 PREPARATION OF FIRE-PROOFED SURFACES

Deck surfaces, both composite and noncomposite, which are to receive sprayed-on fireproofing, shall be galvanized and shall be free of all grease, mill oil, paraffin, dirt, salt, and other contaminants which impair adhesion of the fireproofing. Any required cleaning shall be done prior to steel deck installation using a cleaning method that is compatible with the sprayed-on fireproofing.

## SECTION 05410

## COLD-FORMED STEEL STRUCTURAL FRAMING

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI SG-673 (1986; Addenda 1989; Errata Nov 30, 1990)  
Cold-Formed Steel Design Manual

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 653/653M (1995) Steel Sheet, Zinc-Coated (Galvanized)  
or Zinc-Iron Alloy-Coated (Galvannealed) by  
the Hot-Dip Process

## AMERICAN WELDING SOCIETY (AWS)

AWS D1.3 (1989) Structural Welding Code-Sheet Steel

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL DESCRIPTIONS:

## SD-04 Drawings

Cold formed members; FIO.

Shop drawings shall indicate member gauges, spacings, and sizes; shop and field assembly details including cut and fastenings; type and locations of welds, bolts, and fastening devices; and panel fabrication, with individual panel drawings for each condition including configuration, dimensions, materials, attachments, structural calculations, and panel locations.

## SD-Certificates

Design calculations as necessary to indicate compliance with load-bearing requirements shall be submitted for the following:

Framing; FIO. Studs; FIO. Joists; FIO. Runners; FIO.

## 1.3 DELIVERY AND STORAGE

Materials shall be delivered to the site in undamaged condition and stored off the ground in a well drained, ventilated, dry location; protected from damage; protected from rain or snow by impervious covering or shelter; properly supported on a level platform; and shall be easily accessible for

inspection and handling. Handle materials carefully to prevent damage. Replace damaged items with new.

## 2 PRODUCTS

### 2.1 STEEL STUDS FOR EXTERIOR WALL FRAMING

Studs shall be formed from G60 galvanized steel sheets conforming to ASTM A 653/653M, Grade 345 for 12, 14, and 16 gauges and Grade 230 for 18 and 20 gauges. Studs shall be C-shaped, sized as shown on the drawings. Stud flanges shall be not less than 35 mm wide, and each flange shall, in addition, have a stiffening lip bent parallel to the stud web.

### 2.2 CEILING AND FLOOR RUNNER CHANNELS, BRIDGING, AND ACCESSORIES

Formed from 20 gauge standard commercial G60 galvanized steel sheets with a minimum yield point of 230 MPa. Track shall be C-shaped with web dimension to receive stud ends, and with flange dimension not less than 32 mm .

### 2.3 FASTENERS

Screws shall be corrosion-resistant, self-tapping and self-drilling type, with pan head; size as recommended by steel framing manufacturer.

### 2.4 FABRICATION

Cold-formed steel structural framing shall be designed and fabricated to conform to AISI SG-673.

## 3 EXECUTION

### 3.1 ERECTION

#### 3.1.1 Studs

Studs shall be seated squarely in the track with flanges abutting the track web, plumbed and aligned. Fasten studs to the top and bottom runner channels by welding or screwing both flanges to the runner channels. All studs shall be full wall height without splices. Jack studs shall be provided between track and sills, and between door and window headers and top track. Provide double studs at jambs of door and window openings and at control joints. Provide not less than three studs at corners. All welds shall be fillet, plug, butt, or seam. Install diagonal stud bracing between door and window headers and the top track. Stud spacing shall be as shown.

#### 3.1.2 Floor Runner Channels

Channels shall be accurately aligned and securely attached in place. Attachment shall be by expansion shields and machine bolts, self-drilling anchors, or other approved methods with shear load capacity of 158.8 kg minimum. Space anchors 600 mm on center maximum. Butt welds or splices shall be made at all butt joints in the channel.

### 3.1.3 Ceiling Runner Channels

Channels shall be fitted and attached to studs as specified for the floor runner channel attachment. Ceiling runner channels shall continue across control joints without splices.

### 3.1.4 Special Framing

Special framing shall be provided at corners, intersections, jambs of openings, and over door and window openings to distribute the structural loads imposed and to provide attachment surfaces for connecting materials.

### 3.1.5 Temporary Bracing

Temporary bracing shall be provided until erection is completed.

### 3.1.6 Bridging

Bridging may be either C-shaped stud member cut to fit between stud webs, or continuous 38 mm cold rolled channel inserted through stud web cut-outs. Attach bridging to each web by welding. Unless otherwise shown on the drawings, horizontal bridging shall be spaced not greater than 1525 mm on center for wind loaded walls and 1016 mm on center for axial loaded walls.

### 3.1.7 Diagonal Bracing

Provide diagonal bracing where required. Attach by welding to floor and ceiling runner channels and at each stud intersection.

### 3.1.8 Welding

Welding shall be in accordance with AWS D1.3. A wire feeder type welder may be used.

### 3.1.9 Steel Framing System

System shall be designed to carry the full design wind load with the maximum deflection limited to  $L/600$ . Framing Components shall be cut square or on an angle as in bracing to fit square against abutting members. Members shall be held firmly in position until properly fastened.

### 3.1.10 Web Stiffeners

Stiffeners shall be provided at concentrated load points and at end reactions whenever the web height/thickness ratio exceeds 200.

### 3.1.11 Panel Fabrication

Framing components may be prefabricated into panels prior to erection. Prefabricated panels shall be square and braced against racking. Lifting of prefabricated panels shall be done in a manner to avoid local distortion in any member.

### 3.1.12 Attachments

Attachments of similar components shall be done by welding. Dissimilar framing components shall be attached by welding, screen attachment or by

bolting. Wire tying of framing components in structural applications will not be permitted. All welds shall be touched up with a zinc-rich paint.

## SECTION 05500

## MISCELLANEOUS METAL

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## ALUMINUM ASSOCIATION (AA)

AA DAF-45 (1980; R 1993) Designation System for Aluminum Finishes

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A14.3 (1992) Ladders - Fixed - Safety Requirements

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36 (1996) Carbon Structural Steel

ASTM A 53 (1996) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

ASTM A 123 (1989a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A 283 (1993a) Low and Intermediate Tensile Strength Carbon Steel Plates

ASTM A 467 (1993) Machine and Coil Chain

ASTM A 500 (1993) Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

ASTM A 653 (1996) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

ASTM A 924 (1996a) Steel Sheet, Metallic-Coated by the Hot-Dip Process

ASTM D 2047 (1993) Static Coefficient of Friction of Polish-Coated Floor Surfaces as Measured by the James Machine

## AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7 (1995) Minimum Design Loads for Buildings and Other Structures

## AMERICAN WELDING SOCIETY (AWS)

AWS D1.1 (1994) Structural Welding Code - Steel

## COMMERCIAL ITEM DESCRIPTIONS (CID)

CID A-A-344 (Rev B) Lacquer, Clear Gloss, Exterior,  
Interior

## NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM MBG 531 (1993) Metal Bar Grating Manual

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 211 (1992) Chimneys, Fireplaces, Vents and Solid  
Fuel-Burning Appliances

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

## SD-04 Drawings

Miscellaneous Metal Items; FIO.

Detail drawings indicating material thickness, type, grade, and class; dimensions; and construction details. Drawings shall include catalog cuts, erection details, manufacturer's descriptive data and installation instructions, and templates. Detail drawings for the following items:

access doors, stairs.

## SD-14 Samples

Miscellaneous Metal Items; FIO.

Samples shall be full size, taken from manufacturer's stock, and shall be complete as required for installation in the structure. Samples may be installed in the work, provided each sample is clearly identified and its location recorded.

## 1.3 GENERAL REQUIREMENTS

The Contractor shall verify all measurements and shall take all field measurements necessary before fabrication. Welding to or on structural steel shall be in accordance with AWS D1.1. Items specified to be galvanized, when practicable and not indicated otherwise, shall be hot-dip galvanized after fabrication. Galvanizing shall be in accordance with ASTM A 123, ASTM A 653, or ASTM A 924, as applicable. Exposed fastenings shall be compatible materials, shall generally match in color and finish, and shall harmonize with the material to which fastenings are applied. Materials and parts necessary to complete each item, even though such work is not definitely shown or specified, shall be included. Poor matching of



holes for fasteners shall be cause for rejection. Fastenings shall be concealed where practicable. Thickness of metal and details of assembly and supports shall provide strength and stiffness. Joints exposed to the weather shall be formed to exclude water.

#### 1.4 DISSIMILAR MATERIALS

Where dissimilar metals are in contact, or where aluminum is in contact with concrete, mortar, masonry, wet or pressure-treated wood, or absorptive materials subject to wetting, the surfaces shall be protected with a coat of bituminous paint or asphalt varnish.

#### 1.5 WORKMANSHIP

Miscellaneous metalwork shall be well formed to shape and size, with sharp lines and angles and true curves. Drilling and punching shall produce clean true lines and surfaces. Welding shall be continuous along the entire area of contact except where tack welding is permitted. Exposed connections of work in place shall not be tack welded. Exposed welds shall be ground smooth. Exposed surfaces of work in place shall have a smooth finish, and unless otherwise approved, exposed riveting shall be flush. Where tight fits are required, joints shall be milled. Corner joints shall be coped or mitered, well formed, and in true alignment. Work shall be accurately set to established lines and elevations and securely fastened in place. Installation shall be in accordance with manufacturer's installation instructions and approved drawings, cuts, and details.

#### 1.6 ANCHORAGE

Anchorage shall be provided where necessary for fastening miscellaneous metal items securely in place. Anchorage not otherwise specified or indicated shall include slotted inserts made to engage with the anchors, expansion shields, and power-driven fasteners when approved for concrete; toggle bolts and through bolts for masonry; machine and carriage bolts for steel; and lag bolts and screws for wood.

#### 1.7 ALUMINUM FINISHES

Unless otherwise specified, aluminum items shall have standard mill finish. The thickness of the coating shall be not less than that specified for protective and decorative type finishes for items used in interior locations or architectural Class I type finish for items used in exterior locations in AA DAF-45. Items to be anodized shall receive a polished satin finish. Aluminum surfaces to be in contact with plaster or concrete during construction shall be protected with a field coat conforming to CID A-A-344.

#### 1.8 SHOP PAINTING

Surfaces of ferrous metal except galvanized surfaces, shall be cleaned and shop coated with the manufacturer's standard protective coating unless otherwise specified. Surfaces of items to be embedded in concrete shall not be painted. Items to be finish painted shall be prepared according to manufacturer's recommendations or as specified.

## 2 PRODUCTS

### 2.1 ACCESS DOORS AND PANELS

Doors and panels shall be flush type unless otherwise indicated. Frames for access doors shall be fabricated of not lighter than 1.52 mm (16 gauge) steel with welded joints and finished with anchorage for securing into construction. Access doors shall be a minimum of 350 by 500 mm and of not lighter than 1.9 mm (14 gauge) steel, with stiffened edges, complete with attachments. Access doors shall be hinged to frame and provided with a flush face, screw driver operated latch. Exposed metal surfaces shall have a baked enamel finish or shop applied prime coat as required for the specific installation.

### 2.2 CHIMNEYS, VENTS, AND SMOKESTACKS

Chimneys and vents shall be designed and constructed in accordance with NFPA 211. Chimney connectors shall be formed of not lighter than 1.01 mm (20 gauge) galvanized steel. Stacks shall be designed and constructed to withstand a wind velocity of 130 km/h in accordance with ASCE 7. Unlined stacks shall be constructed of black-steel plates not less than 5 mm thick conforming to ASTM A 36. Seams and joints shall be welded, except that an angle flange shall be provided for connection to the boiler, other equipment, and stack support.

### 2.3 CORNER GUARDS AND SHIELDS

Corner guards and shields for jambs and sills of openings and edges of platforms shall be steel shapes and plates anchored in masonry or concrete with welded steel straps or end weld stud anchors. Corner guards for use with glazed or ceramic tile finish on walls shall be formed of 1.6 mm thick corrosion-resisting steel with polished or satin finish, shall extend 1.5 m above the top of cove base or to the top of the wainscot, whichever is less, and shall be securely anchored to the supporting wall. Corner guards on exterior shall be galvanized.

### 2.4 DOOR GUARDS

Door guards shall be constructed of woven steel wire or expanded metal framed with structural steel shapes. Expanded metal guards shall be of 38 mm No. 10 mesh, welded to 25 by 25 by 3 mm angle frame. Woven-wire panel shall be of 10 gauge, 38 mm mesh secured through weaving to 25 mm channel frame or around a 10 mm round bar frame. Corners of frames shall be mitered and welded. Guards shall be sized as indicated.

### 2.5 PIPE GUARDS (BOLLARDS)

Pipe guards shall be heavy duty steel pipe conforming to ASTM A 53, Type E or S, weight STD, black finish.

### 2.6 DOWNSPOUT BOOTS

Downspout boots shall be cast aluminum with receiving bells sized to fit downspouts.

## 2.7 EXPANSION JOINT COVERS

Expansion joint covers shall be constructed of extruded aluminum with anodized satin finish for walls and ceilings and with standard mill finish for floor covers and exterior covers. Plates, backup angles, expansion filler strip and anchors shall be designed as indicated.

## 2.8 FLOOR GRATINGS AND FRAMES

Carbon steel grating shall be designed in accordance with NAAMM MBG 531 or NAAMM MBG 532, whichever is most restrictive, to meet the indicated load requirements. Edges shall be banded with bars 6 mm less in height than bearing bars for grating sizes above 19 mm. Banding bars shall be flush with the top of bearing grating. Frames shall be of welded steel construction finished to match the grating. Floor gratings and frames shall be shop primed.

## 2.9 FLOOR PLATES

Floor plates shall be 6 mm thick, slip-resistant, carbon steel conforming to ASTM A 283 having a minimum static coefficient of friction of 0.50 when tested in accordance with ASTM D 2047. Wearing surface shall be aluminum oxide or silicon carbide.

## 2.10 HANDRAILS

Handrails shall be designed to resist a concentrated load of 890 N (200 pounds) in any direction at any point of the top of the rail or 292 Newtons per meter (20 pounds per foot) applied horizontally to top of the rail, whichever is more severe.

### 2.10.1 Steel Handrails, Including Carbon Steel Inserts

Steel handrails, including inserts in concrete, shall be steel pipe conforming to ASTM A 53 or structural tubing conforming to ASTM A 500, Grade A or B of equivalent strength. Refer to drawings for required shapes. Steel railings shall be sized as shown. Railings shall be shop painted. Pipe collars shall be hot-dip galvanized steel.

- a. Joint posts, rail, and corners shall be fabricated by one of the following methods:

- (1) Flush type rail fittings of commercial standard, welded and ground smooth with railing splice locks secured with 10 mm hexagonal recessed-head setscrews.

- (2) Mitered and welded joints by fitting post to top rail and intermediate rail to post, mitering corners, groove welding joints, and grinding smooth. Railing splices shall be butted and reinforced by a tight fitting interior sleeve not less than 150 mm long.

- (3) Railings may be bent at corners in lieu of jointing, provided bends are made in suitable jigs and the pipe is not crushed.

- b. Removable sections, toe-boards, and brackets shall be provided as indicated.

## 2.11 FIRE EXTINGUISHER CABINETS

Metal fire extinguisher cabinets shall be furnished and installed where shown on the drawings or specified. Cabinets shall be of the recessed type as shown. Box and trim shall be of heavy gage rolled steel. Door shall be a rigid frame with full length piano type hinge and double strength (DSA) glass panel. Door and box shall be prim-coated inside and out.

## 2.12 LADDERS

Ladders shall be galvanized steel or aluminum, fixed rail type in accordance with ANSI A14.3.

## 2.13 MIRROR FRAMES

Frames for plate glass mirrors larger than 450 by 750 mm shall be fabricated from extruded aluminum with anodized finish. Frames shall be provided with concealed fittings and tamperproof mountings.

## 2.14 MISCELLANEOUS

Miscellaneous plates and shapes for items that do not form a part of the structural steel framework, such as lintels, sill angles, miscellaneous mountings, and frames, shall be provided to complete the work.

## 2.15 ROLL-UP FLOOR MATS

Roll-up mats shall be of aluminum construction with carpet Roll-up mats shall be for use in recessed area. Construction details of recessed areas shall be shown on the drawings.

## 2.16 SAFETY CHAINS

Safety chains shall be galvanized welded steel, proof coil chain tested in accordance with ASTM A 467, Class CS. Safety chains shall be straight link style, 5 mm diameter, minimum 39 links per meter and with bolt type snap hooks on each end. Eye bolts for attachment of chains shall be galvanized 10 mm bolt with 19 mm eye, anchored as indicated. Two chains shall be furnished for each guarded opening.

## 2.17 SAFETY NOSING

Safety nosings shall be of cast aluminum with abrasive surface. Nosing shall be 75 mm wide and terminating at not more than 150 mm from the ends of treads, except nosing for metal pan cement-filled treads shall extend the full length of the tread. Safety nosings shall be provided with anchors not less than 19 mm long. Integrally cast mushroom anchors are not acceptable.

## 2.18 STEEL STAIRS

Steel stairs shall be complete with structural or formed channel stringers, metal pan concrete-filled treads, landings, columns, handrails, and necessary bolts and other fastenings as indicated. Structural steel shall conform to ASTM A 36. Stairs and accessories shall be shop primed. Risers on stairs with metal pan treads shall be deformed to form a sanitary cove to retain the tread concrete. Integral nosings shall have braces extended into

the concrete fill. Gratings for treads and landings shall conform to NAAMM MBG 531. Grating treads shall have slip-resistant nosings.

## 2.19 STEEL DOOR FRAMES

Steel door frames built from structural shapes shall be neatly mitered and securely welded at the corners with all welds ground smooth. Jambs shall be provided with 50 by 6 by 300 mm bent, adjustable metal anchors spaced not over 760 mm on centers. Provision shall be made to stiffen the top member for all spans over 900 mm. Continuous door stops shall be made of 38 by 16 mm bars.

## 3 EXECUTION

### 3.1 GENERAL INSTALLATION REQUIREMENTS

All items shall be installed at the locations shown and according to the manufacturer's recommendations. Items listed below require additional procedures as specified.

### 3.2 REMOVABLE ACCESS PANELS

A removable access panel not less than 300 by 300 mm shall be installed directly below each valve, flow indicator, damper, or air splitter that is located above the ceiling, other than an acoustical ceiling, and that would otherwise not be accessible.

### 3.3 INSTALLATION OF CHIMNEYS, VENTS, AND SMOKESTACKS

Chimneys and vents shall be installed in accordance with NFPA 211. A cleanout opening with a tight-fitting, hinged, cast-iron door and frame shall be provided at the base of each smokestack. A top band shall be provided on stacks for attachment of painter's rigging. Roof housing, rain cap, downdraft diverter, fire damper, and other accessories required for a complete installation shall be provided. Sections of prefabricated lined stacks shall be joined with acid-resisting high-temperature cement and steel draw bands. Means to prevent accumulation of water in the smokestack shall be provided.

### 3.4 DOOR GUARD FRAME

Door guard frame shall be mounted over the glazed opening using 6 mm lag bolts on the interior of wood doors or tamperproof through bolts on the interior of metal doors.

### 3.5 INSTALLATION OF PIPE GUARDS

Pipe guards shall be set vertically in concrete piers. Piers shall be constructed of, and the hollow cores of the pipe filled with concrete having a compressive strength of 21 Mpa at 28 days as specified in SECTION 03300 CAST-IN-PLACE STRUCTURAL CONCRETE.

### 3.6 INSTALLATION OF DOWNSPOUT BOOTS

Downspouts shall be secured to building through integral lips with appropriate fasteners.

### 3.7 ATTACHMENT OF HANDRAILS

Toeboards and brackets shall be installed where indicated. Splices, where required, shall be made at expansion joints. Removable sections shall be installed as indicated.

#### 3.7.1 Installation of Steel Handrails

Installation shall be in pipe sleeves embedded in concrete and filled with molten lead or sulphur with anchorage covered with standard pipe collar pinned to post, masonry with expansion shields and bolts or toggle bolts, base plates bolted to stringers or structural steel framework. Rail ends shall be secured by steel pipe flanges anchored by expansion shields and bolts, through-bolted to a back plate or by 6 mm lag bolts to studs or solid backing, as applicable.

### 3.8 PARTITION POSTS AND OPENINGS

Posts shall be set in shoes bolted to the floor and in caps tap-screwed to clip angles in overhead construction, as indicated. Openings shall be formed using channels similar to the partition frames at ducts, pipes, and other obstructions.

### 3.9 RECESSED FLOOR MATS

Contractor shall verify field measurements prior to releasing materials for fabrication by the manufacturer. A mat frame shall be used to ensure recess accuracy in size, shape and depth. Drain pit shall be formed by blocking out concrete when frames are installed. Pit shall be dampproofed after concrete has set. Frames shall be assembled onsite and installed so that upper edge will be level with finished floor surface. A cement base shall be screeded inside the mat recess frame area using the edge provided by the frame as a guide. The frame shall be anchored into the cement with anchor pins a minimum of 610 mm on centers.

### 3.10 MOUNTING OF SAFETY CHAINS

Safety chains shall be mounted 1070 mm and 610 mm above the floor.

### 3.11 INSTALLATION OF SAFETY NOSINGS

Nosing shall be completely embedded in concrete before the initial set of the concrete occurs and shall finish flush with the top of the concrete surface.

### 3.12 DOOR FRAMES

Door frames shall be secured to the floor slab by means of angle clips and expansion bolts. Continuous door stops shall be welded to the frame or tap screwed with countersunk screws at no more than 450 mm centers, assuring in either case full contact with the frame. Any necessary reinforcements shall be made and the frames shall be drilled and tapped as required for hardware.

## SECTION 06100

## ROUGH CARPENTRY

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN FOREST AND PAPER ASSOCIATION (AFPA)

- |               |   |
|---------------|---|
| AFPA-T901     | (1991; Supple 1993; Addenda Apr 95)National<br>Design Specification for Wood Construction |
| AFPA T11-WCD1 | (1988) Manual for Wood Frame Construction   |

## AMERICAN HARDBOARD ASSOCIATION (AHA)

- |            |                              |
|------------|------------------------------|
| AHA A194.1 | (1985) Cellulosic Fiberboard |
|------------|------------------------------|

## AMERICAN INSTITUTE OF TIMBER CONSTRUCTION (AITC)

- |          |  |
|----------|--|
| AITC 111 | (1979) Recommended Practice for Protection of<br>Structural Glued Laminated Timber During<br>Transit, Storage and Erection |
|----------|--|

## APA-THE ENGINEERED WOOD ASSOCIATION (APA)

- |              |  |
|--------------|--|
| APA E445     | (1991; Rev Jan 1996) Performance Standards<br>and Policies for Structural-Use Panels |
| APA EWS R540 | (1996) Proper Storage and Handling of Glulam<br>Beams                                |

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- |            |  |
|------------|--|
| ASTM A 307 | (1994) Carbon Steel Bolts and Studs, 60 000<br>PSI Tensile Strength  |
| ASTM C 79  | (1994) Gypsum Sheathing Board  |
| ASTM C 208 | (1995) Cellulosic Fiber Insulating Board   |
| ASTM C 516 | (1980; R 1990) Vermiculite Loose Fill Thermal<br>Insulation  |
| ASTM C 518 | (1991) Steady-State Heat Flux Measurements<br>and Thermal Transmission Properties By Means<br>of the Heat Flow Meter Apparatus |
| ASTM C 549 | (1981; R 1995) Perlite Loose Fill Insulation   |

ASTM C 553	(1992) Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C 578	(1995) Rigid, Cellular Polystyrene Thermal Insulation
ASTM C 591	(1994) Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM C 665	(1994) Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
ASTM C 1013	(1994) Faced Rigid Cellular Polyisocyanurate Roof Insulation
ASTM C 1136	(1992) Flexible, Low Permeance Vapor Retarders for Thermal Insulation
ASTM C 1289	(1995) Faced Rigid Cellular
ASTM E 84	(1996a) Surface Burning Characteristics of Building Materials
ASTM E 96	(1995) Water Vapor Transmission of Materials
ASTM E 154	(1988; R 1993) Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover
ASTM F 547	(1977; R 1990) Definitions of Terms Relating to Nails for Use with Wood and Wood-Base Materials

## AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)

AWPA C2	(1995) Lumber, Timber, Bridge Ties and Mine Ties - Preservative Treatment by Pressure Processes
AWPA C9	(1995) Plywood - Preservative Treatment by Pressure Processes
AWPA M4	(1995) Standard for the Care of Preservative-Treated Wood Products
AWPA P5	(1996) Standards for Waterborne Preservatives

## DEPARTMENT OF COMMERCE (DOC)

DOC PS 1	(1996) Voluntary Product Standard - Construction and Industrial Plywood
DOC PS 2	(1992) Performance Standards for Wood-Based Structural-Use Panels



## FACTORY MUTUAL ENGINEERING AND RESEARCH (FM)

FM P7825c

(1997) Approval Guide Building Materials

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

## SD-01 Data

Structural Wood Members; FIO.

Design analysis and calculations of structural laminated members, fabricated wood trusses, and other fabricated structural members showing design criteria used to accomplish the applicable analysis.

Product Installations; FIO.

List containing name and location of successful installation of similar type of fabricated structural members specified herein.

## SD-04 Drawings

Installation of Framing; FIO.

Drawings of structural laminated members, fabricated wood trusses, engineered wood joists and rafters, and other fabricated structural members indicating materials, shop fabrication, and field erection details; including methods of fastening.

Nailers and Nailing Strips; FIO.

Drawings of field erection details, including materials and methods of fastening nailers in conformance with Factory Mutual wind uplift rated systems specified in other Sections of these specifications.

## SD-13 Certificates

Grading and Marking; FIO.

Manufacturer's certificates (approved by an American Lumber Standards approved agency) attesting that lumber and material not normally grade marked meet the specified requirements. Certificate of Inspection for grade marked material by an American Lumber Standards Committee (ALSC) recognized inspection agency prior to shipment.

Insulation; FIO.

Certificate attesting that the cellulose, perlite, glass and mineral fiber, polyurethane, or polyisocyanurate insulation furnished for the project contains recovered material, and showing an estimated percent of such recovered material.

### 1.3 DELIVERY AND STORAGE

Materials shall be delivered to the site in undamaged condition, stored off ground in fully covered, well ventilated areas, and protected from extreme changes in temperature and humidity. Laminated timber shall be handled and stored in accordance with AITC 111 or APA EWS R540.

## 2 PRODUCTS

### 2.1 LUMBER AND SHEATHING

#### 2.1.1 Grading and Marking

##### 2.1.1.1 Lumber Products

Solid sawn and finger-jointed lumber shall bear an authorized gradestamp or grademark recognized by ALSC, or an ALSC recognized certification stamp, mark, or hammerbrand. Surfaces that are to be exposed to view shall not bear grademarks, stamps, or any type of identifying mark. Hammer marking will be permitted on timbers when all surfaces will be exposed to view.

##### 2.1.1.2 Plywood and other Sheathing Products

Materials shall bear the grademark or other identifying marks indicating grades of material and rules or standards under which produced, including requirements for qualifications and authority of the inspection organization. Except for plywood and structural-use panels, bundle marking will be permitted in lieu of marking each individual piece. Surfaces that are to be exposed to view shall not bear grademarks or other types of identifying marks.

##### 2.1.2 Sizes

Lumber and material sizes shall conform to requirements of the rules or standards under which produced. Unless otherwise specified, lumber shall be surfaced on four sides. Unless otherwise specified, sizes indicated are nominal sizes, and actual sizes shall be within manufacturing tolerances allowed by the standard under which the product is produced.

##### 2.1.3 Treatment

Exposed areas of treated wood that are cut or drilled after treatment shall receive a field treatment in accordance with AWP M4. Items of all-heart material of cedar, cypress, or redwood will not require preservative treatment, except when in direct contact with soil. Except as specified for all-heart material of the previously mentioned species, the following items shall be treated:

- a. Wood members in contact with or within 455 mm of soil.
- b. Wood members in contact with water.
- c. Wood members exposed to the weather including those used in builtup roofing systems or as nailing strips or nailers over fiberboard or gypsum-board wall sheathing as a base for wood siding.

- d. Wood members set into concrete regardless of location, including flush-with-deck wood nailers for roofs.
- e. Wood members in contact with concrete that is in contact with soil or water or that is exposed to weather.

#### 2.1.3.1 Lumber and Timbers

Lumber and timbers shall be treated in accordance with AWPA C2 with waterborne preservatives listed in AWPA P5 to a retention level as follows:

- a. 4 kg per cubic meter intended for above ground use.
- b. 6.4 kg per cubic meter intended for ground contact and fresh water use.

#### 2.1.3.2 Plywood

Plywood shall be treated in accordance with AWPA C9 with waterborne preservatives listed in AWPA P5 to a retention level as follows:

- a. 4 kg per cubic meter intended for above ground use.
- b. 6.4 kg per cubic meter intended for ground contact and fresh water use.

#### 2.1.4 Moisture Content

At the time lumber and other materials are delivered and when installed in the work their moisture content shall be as follows:

- a. Treated and Untreated Lumber Except Roof Planking:

100 mm or less, nominal thickness, 19 percent maximum. 125 mm or more, nominal thickness, 23 percent maximum in a 75 mm perimeter of the timber cross-section.

- b. Roof Planking: 15 percent maximum.

- c. Materials Other Than Lumber: In accordance with standard under which product is produced.

#### 2.1.5 Sheathing

Wall sheathing at exterior insulation finish system shall be gypsum board type. All other sheathing shall be fiberboard, gypsum board, plywood, structural-use panels, or wood for wall sheathing. Roof sheathing is specified elsewhere.

##### 2.1.5.1 Fiberboard

Fiberboard shall conform to ASTM C 208, Type IV, Grade 2, Structural Grade, or AHA A194.1, Type IV, Grade 2 asphalt impregnated or asphalt coated to be water-resistant but vapor permeable.

## 2.1.5.2 Gypsum Board

Gypsum board shall conform to ASTM C 79, 13 mm thick, 1200 mm wide with straight edges for supports 400 mm on center without corner bracing of framing or for supports 600 mm on center with corner bracing of framing; 600 mm wide with V-tongue and groove edges for supports 400 or 600 mm on center with corner bracing of framing. Sheathing shall have a silicone treated core with glass fiber mat facing on both sides with an alkali-resistant coating. Gypsum sheathing shall meet a permeance rating of 23 or better using the ASTM E 96 (dry cup method). Surface water absorption shall be no more than .84 grams when tested in accordance with ASTM C 1177. Flame spread shall be no greater than 0 and both face and core shall be classified as noncombustible.

Acceptable product/manufacturer: 'Dens-Glass Gold'; Georgia-Pacific Corp.

## 2.1.5.3 Plywood

Plywood shall conform to DOC PS 1, APA E445 or DOC PS 2, Grade C-D with exterior glue. Sheathing for roof and walls without corner bracing of framing shall have a span rating of 16/0 or greater for supports 400 mm on center and a span rating of 24/0 or greater for supports 600 mm on center.

## 2.1.5.4 Wood

Species and grade shall be in accordance with TABLE I at the end of this section. Wall sheathing shall be 25 mm thick for supports 400 or 600 mm on center without corner bracing of framing provided sheathing is applied diagonally. Roof sheathing shall be 25 mm thick for supports 400 or 600 mm on center.

## 2.1.6 Miscellaneous Wood Members

## 2.1.6.1 Nonstress Graded Members

Members shall include bridging, corner bracing, furring, grounds, and nailing strips. Members shall be in accordance with TABLE I for the species used. Sizes shall be as follows unless otherwise shown:

Member	Size mm
Bridging	25 x 75 or 25 x 100 for use between members 50 x 300 and smaller; 50 x 100 for use between members larger than 50 x 300.
Corner bracing	25 x 100.
Furring	25 x 50
Grounds	Plaster thickness by 38.
Nailing strips	25 x 75 or 25 x 100 when used as shingle base or interior finish, otherwise 50 mm stock.

#### 2.1.6.2 Wood Bumpers

Bumpers shall be of the species and grade in accordance with TABLE II at the end of this section, size as shown.

#### 2.1.6.3 Sill Plates

Sill plates shall be standard or number 2 grade.

#### 2.1.6.4 Blocking

Blocking shall be standard or number 2 grade.

#### 2.1.6.5 Rough Bucks and Frames

Rough bucks and frames shall be straight standard or number 2 grade.

### 2.2 ACCESSORIES AND NAILS

Markings shall identify both the strength grade and the manufacturer. Accessories and nails shall conform to the following:

#### 2.2.1 Anchor Bolts

ASTM A 307, size as indicated, complete with nuts and washers.

#### 2.2.2 Bolts: Lag, Toggle, and Miscellaneous Bolts and Screws

Type, size, and finish best suited for intended use. Finish options include zinc compounds, cadmium, and aluminum paint impregnated finishes.

#### 2.2.3 Clip Angles

Steel, 5 mm thick, size best suited for intended use; or zinc-coated steel or iron commercial clips designed for connecting wood members.

#### 2.2.4 Expansion Shields

Type and size best suited for intended use.

#### 2.2.5 Nails and Staples

ASTM F 547, size and type best suited for purpose; staples shall be as recommended by the manufacturer of the materials to be joined. For sheathing and subflooring, length of nails shall be sufficient to extend 25 mm into supports. In general, 8-penny or larger nails shall be used for nailing through 25 mm thick lumber and for toe nailing 50 mm thick lumber; 16-penny or larger nails shall be used for nailing through 50 mm thick lumber. Nails used with treated lumber and sheathing shall be galvanized. Nailing shall be in accordance with the recommended nailing schedule contained in AFPA T11-WCD1. Where detailed nailing requirements are not specified, nail size and spacing shall be sufficient to develop an adequate strength for the connection. The connection's strength shall be verified against the nail capacity tables in AFPA-T901. Reasonable judgement backed by experience shall ensure that the designed connection will not cause the

wood to split. If a load situation exceeds a reasonable limit for nails, a specialized connector shall be used.

## 2.3 INSULATION

Thermal resistance of insulation shall be not less than the R-values shown. R-values shall be determined at 24 degrees C in accordance with ASTM C 518. Insulation shall contain the highest practicable percentage of recovered material which has been recovered or diverted from solid waste, but not including material reused in a manufacturing process. Where two materials have the same price and performance, the one containing the higher recovered material content shall be provided. Insulation shall be the standard product of a manufacturer and factory marked or identified with manufacturer's name or trademark and R-value. Identification shall be on individual pieces or individual packages. Materials containing more than one percent asbestos will not be allowed.

### 2.3.1 Batt or Blanket

#### 2.3.1.1 Glass Fiber Batts and Rolls

Glass fiber batts and rolls shall conform to ASTM C 665, Type I unfaced insulation, Type II kraft faced insulation or Type III foil faced insulation, Class A, having a UL rating of 25 and a smoke developed rating of 150 or less when tested in accordance with ASTM E 84. Refer to drawings for required type. Width and length shall suit construction conditions.

#### 2.3.1.2 Mineral Fiber Batt

Mineral fiber batt shall conform to ASTM C 665, Type I unfaced insulation.

#### 2.3.1.3 Mineral Fiber Blanket

Mineral fiber blanket shall conform to ASTM C 553, Type I, Class 6. Blankets shall be sized to suit construction conditions, resilient type for use below and above ambient temperature to 195 degrees C. Blankets shall have a factory applied vapor-barrier facing on one side with 50 mm nailing tabs on both edges. Vapor barriers shall be fire retardant, high vapor transmission, and aluminum foil laminated to crepe paper type conforming to ASTM C 1136, Type II. Nominal density shall be 12 kg per cubic meter.

### 2.3.2 Loose Fill or Granular Fill

#### 2.3.2.1 Vermiculite

Vermiculite shall conform to ASTM C 516, Type II.

#### 2.3.2.2 Perlite

Perlite shall conform to ASTM C 549, Type II with minimum recovered material content of 23 percent by weight of core material.

### 2.3.3 Sill Sealer

Mineral wool, 25 mm thick and compressible to 0.8 mm, width of sill, designed to perform as an air, dirt, and insect seal in conformance with ASTM C 665, Type I.

### 2.3.4 Rigid Insulation

#### 2.3.4.1 Polystyrene Board

Polystyrene board shall be extruded and conform to ASTM C 578, Type IV.

#### 2.3.4.2 Polyurethane or Polyisocyanurate Board

Polyurethane or polyisocyanurate board shall conform to ASTM C 1013(having a minimum recovered material content of 9 percent by weight of core material in the polyurethane or polyisocyanurate portion). Unfaced preformed polyurethane shall conform to ASTM C 591. Faced polyisocyanurate shall conform to ASTM C 1289.

### 2.4 VAPOR RETARDER

Vapor retarder shall be foil conforming to ASTM E 154. Vapor retarder shall have a maximum vapor permeance rating of 29 ng per Pa per second per square meter as determined in accordance with ASTM E 96, unless otherwise specified.

## 3 EXECUTION

### 3.1 INSTALLATION OF FRAMING

#### 3.1.1 General

Members shall be closely fitted, accurately set to required lines and levels, and rigidly secured in place. Members shall be framed for passage of ducts. Members shall be cut, notched, or bored in accordance with applicable requirements of AFPA-T901 for the passage of pipes, wires, or conduits. Rafters, purlins, and joists shall be set with crown edge up. Framing shall be kept at least 50 mm away from chimneys and 100 mm away from fireplace backwalls. When joists, beams, and girders are placed on masonry or concrete, a wood base plate shall be positioned and leveled with grout. The joist, beam, or girder shall then be placed on the plate. When joists, beams, and girders are set into masonry or concrete, a pocket shall be formed into the wall. The joist, beam, or girder shall then be placed into the pocket and leveled with a steel shim.

#### 3.1.2 Structural Members

Members shall be adequately braced before erection. Members shall be aligned and all connections completed before removal of bracing. Individually wrapped members shall be unwrapped only after adequate protection by a roof or other cover has been provided. Scratches and abrasions of factory-applied sealer shall be treated with two brush coats of the same sealer used at the factory.

### 3.2 INSTALLATION OF SHEATHING

#### 3.2.1 Fiberboard

Sheathing shall be applied with edges 3 mm apart at joints, fitted snugly at abutting frames of openings, and nailed or stapled in accordance with the manufacturer's approved instructions. Sheets shall be applied vertically,

extended over top and bottom plates, and with all vertical and horizontal joints over supports.

### 3.2.2 Gypsum Board

Sheathing shall be applied with edges in light contact at joints and nailed in accordance with the manufacturer's approved instructions. Sheets 600 mm wide shall be applied horizontally with tongued edge up, with vertical joints over supports, and with vertical joints staggered. Sheets 1200 mm wide shall be applied vertically, extended over top and bottom plates, and with all vertical and horizontal joints over supports.

### 3.2.3 Plywood and Structural-Use Panels

Sheathing shall be applied with edges 3 mm apart at side and end joints, and nailed at supported edges at 150 mm on center and at intermediate supports 300 mm on center unless otherwise shown. Nailing of edges shall be 10 mm from the edges. Wall sheathing shall extend over top and bottom plates, and if applied horizontally the vertical joints shall be made over supports and staggered. Wall sheathing over which wood shingles are to be applied shall be applied horizontally. Roof sheathing shall be applied with long dimension at right angles to supports, end joints made over supports, and end joints staggered.

### 3.2.4 Wood

Sheathing end joints shall be made over framing members and so alternated that there will be at least two boards between joints on the same support. Each board shall bear on at least three supports. Boards shall be nailed at each support using two nails for boards 150 mm and less in width and three nails for boards more than 150 mm in width. Roof sheathing shall not be installed where roof decking is installed.

## 3.3 INSTALLATION OF MISCELLANEOUS WOOD MEMBERS

### 3.3.1 Blocking

Blocking shall be provided as necessary for application of siding, sheathing, subflooring, wallboard, and other materials or building items, and to provide firestopping. Blocking for firestopping shall ensure a maximum dimension of 2400 mm for any concealed space. Blocking shall be cut to fit between framing members and rigidly nailed thereto.

### 3.3.2 Nailers and Nailing Strips

Nailers and nailing strips shall be provided as necessary for the attachment of finish materials. Nailers used in conjunction with roof deck installation shall be installed flush with the roof deck system. Stacked nailers shall be assembled with spikes or nails spaced not more than 450 mm on center and staggered. Beginning and ending nails shall not be more than 150 mm for nailer end. Ends of stacked nailers shall be offset approximately 300 mm in long runs and alternated at corners. Anchors shall extend through the entire thickness of the nailer. Strips shall be run in lengths as long as practicable, butt jointed, cut into wood framing members when necessary, and rigidly secured in place. Nailers and nailer installation for Factory Mutual wind uplift rated roof systems specified in other Sections of these specifications shall conform to FM P7825c.



### 3.3.3 Wood Grounds

Wood grounds shall be provided as necessary for attachment of trim, finish, and other work to plaster. Grounds shall be run in lengths as long as practicable, butt jointed, and rigidly secured in place.

### 3.3.4 Furring Strips

Furring strips shall be provided at the locations shown. Furring strips shall be installed at 400 mm on center unless otherwise shown, run in lengths as long as practicable, butt jointed and rigidly secured in place.

### 3.3.5 Rough Bucks and Frames

Rough bucks shall be set straight, true, and plumb, and secured with anchors near top and bottom of each wood member and at intermediate intervals of not more than 900 mm. Anchors for concrete shall be expansion bolts, and anchors for masonry shall be 5 x 32 mm steel straps extending not less than 200 mm into the masonry and turned down 50 mm into the masonry.

### 3.3.6 Wood Bumpers

Wood bumpers shall be bored, countersunk and securely bolted in place.

### 3.3.7 Sill Plates

Sill plates shall be set level and square and anchor bolted at not more than 1800 mm on centers and not more than 300 mm from end of each piece. A minimum of two anchors shall be used for each piece.

## 3.4 INSTALLATION OF INSULATION

Insulation shall be installed after construction has advanced to a point that the installed insulation will not be damaged by remaining work. For thermal insulation the actual installed thickness shall provide the thermal resistance shown. For acoustical insulation the installed thickness shall be as shown. Insulation shall be installed on the weather side of such items as electrical boxes and water lines. Unless otherwise specified, installation shall be in accordance with the manufacturer's recommendation.

## 3.5 INSTALLATION OF VAPOR RETARDER

Vapor retarder shall be applied to provide a continuous barrier at window and door frames, and at all penetrations such as electrical outlets and switches, plumbing connections, and utility service penetrations. Joints in the vapor retarder shall be lapped and sealed according to the manufacturer's recommendations.

## SECTION 06200

## FINISH CARPENTRY

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM F 547 (1977; R 1990) Definitions of Terms Relating to Nails for Use with Wood and Wood-Base Materials

## WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)

WWPA-01 (1995; Supple Nos. 1, 2, and 3) Western Lumber Grading Rules 95

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

## SD-04 Drawings

Finish Carpentry; FIO.

Drawings showing fabricated items and special mill and woodwork items. Drawings shall indicate materials and details of construction, methods of fastening, erection, and installation.

## SD-14 Samples

Moldings; FIO. Fascias and Trim; FIO. Solid Acrylic Trim/Countertops; FIO.

Samples shall be of sufficient size to show patterns, color ranges, and types, as applicable, of the material proposed to be used.

## 1.3 DELIVERY AND STORAGE

Materials shall be delivered to the site in undamaged condition, stored off ground in fully covered, well-ventilated areas, and protected from extreme changes in temperature and humidity.

## 2 PRODUCTS

## 2.1 WOOD ITEMS, SIDING, AND TRIM

The Contractor shall furnish products which optimize design by reducing the amount of wood used (engineered wood), or recycled wood products, and

preservatives without arsenic or chromium when the products and methods are competitive in price or directed by the Contracting Officer.

#### 2.1.1 Grading and Marking

Materials shall bear the grademark, stamp or other identifying marks indicating grades of material and rules or standards under which produced. Such identifying marks on a material shall be in accordance with the rule or standard under which the material is produced, including requirements for qualifications and authority of the inspection organization, usage of authorized identification, and information included in the identification. The inspection agency for lumber shall be certified by the Board of Review, American Lumber Standards Committee, to grade the species used. Except for plywood, structural-use panels, and lumber, bundle marking will be permitted in lieu of marking each individual piece. Surfaces that are to be architecturally exposed to view shall not bear grademarks, stamps, or other types of identifying marks.

#### 2.1.2 Sizes and Patterns

Lumber sizes and patterns shall conform to rules or standards under which produced. Unless otherwise specified, lumber shall be surfaced on four sides. Sizes and patterns for materials other than lumber shall conform to requirements of the rules or standards under which produced. Size references, unless otherwise specified, are nominal sizes, and actual sizes shall be within manufacturing tolerances allowed by the standard under which the product is produced.

#### 2.1.3 Moisture Content

The maximum moisture content of untreated trim and wood siding shall be 15 percent at the time of delivery to the jobsite and when installed. Moisture content of all other material shall be in accordance with the standard under which the product is produced.

#### 2.1.4 Fascias and Trim

##### 2.1.4.1 Wood

Fascias and trim, including exterior door and window casing, shall be species and grade listed in TABLE I at the end of this section. Sizes shall be as indicated. Metal corners may be furnished in lieu of wood cornerboards for horizontal siding; and if furnished, shall be galvanized steel and primed or aluminum and primed.

#### 2.1.5 Moldings

Moldings shall be of the pattern indicated and shall be of a grade compatible with the finish specified.

#### 2.1.6 Woodwork Items

##### 2.1.6.1 Utility Shelving

Utility shelving shall be a suitable species equal to or exceeding requirements of No. 3 Common white fir under WWPA-01, 25 mm thick; or plywood, interior type, Grade A-B, 13 mm, any species group.

#### 2.1.6.2 Vanity, Kitchen, Lavatory, Service Area Cabinet Countertops, Window Stools and Desk Work-surfaces

Cabinet countertops, window stools and desktop surfaces where shown shall be solid acrylic and shall be a solid homogeneous material which is non-porous. Solid acrylic shall meet the requirements for Class A fire exposure and shall have a thickness as shown on the drawings. Exposed edges shall be eased, unless otherwise shown.

### 2.2 NAILS

Nails shall be the size and type best suited for the purpose and shall conform to ASTM F 547. Nails shall be hot-dip galvanized or aluminum when used on exterior work. For siding, length of nails shall be sufficient to extend 40 mm into supports, including wood sheathing over framing. Screws for use where nailing is impractical shall be size best suited for purpose.

## 3 EXECUTION

### 3.1 GENERAL

### 3.2 FASCIAS AND EXTERIOR TRIM

Exposed surfaces and square edges shall be machine sanded, caulked, and constructed to exclude water. Joints of built-up items, in addition to nailing, shall be glued as necessary for weather-resistant construction. End joints in built-up members shall be well distributed. Joints in flat work shall be shouldered. Backs of wide-faced miters shall be held together with metal rings and glue. Fascias and other flat members shall be in maximum practicable lengths. Cornices shall be braced, blocked, and rigidly anchored for support and protection of vertical joints.

### 3.3 MOLDING AND INTERIOR TRIM

Molding and interior trim shall be installed straight, plumb, level and with closely fitted joints. Exposed surfaces shall be machine sanded at the mill. Molded work shall be coped at returns and interior angles and mitered at external corners. Intersections of flatwork shall be shouldered to ease any inherent changes in plane. Window and door trim shall be provided in single lengths. Blind nailing shall be used to the extent practicable, and face nailing shall be set and stopped with a nonstaining putty to match the finish applied. Screws shall be used for attachment to metal; setting and stopping of screws shall be of the same quality as required where nails are used.

### 3.4 WOODWORK ITEMS

#### 3.4.1 Shelving

Shelving shall be anchored to supporting construction. Unless otherwise indicated, shelves shall be supported by wall-supported brackets not more than 600 mm on center or as required to limit deflection to 6 mm between supports with a load of 525 N per meter. Adjustable shelf hardware shall be steel standards, channel shaped, with 25 mm adjustment slots and brackets designed for attachment to standards.

#### 3.4.2 Clothes Hanger Rods

Rods shall be provided where indicated and in all closets having hook strips. Rods shall be zinc-coated steel pipe 25 mm in diameter. Rods shall be set parallel with the front edges of the shelving, and shall be supported at each end by suitable sockets, and by intermediate brackets spaced at not more than 1200 mm centers.

## SECTION 06410

## WOOD CABINETS

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE, INC. (ANSI) PUBLICATION:

ANSI A156.9 (1988) Cabinet Hardware

AMERICAN WOODWORK INSTITUTE, (AWI):

Architectural Woodwork      Guide Specifications and Quality  
Quality Standards      Certification Program  
   (6<sup>th</sup> edition, Version 1.0, 1993)

FEDERAL SPECIFICATION (FED. SPEC.):

FS MMM-A-130 (Rev B, Int. Am. 3) Adhesive, Contact

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA) STANDARD:

NEMA LD 3 (1995) High-Pressure decorative Laminates

## 1.2 GENERAL

Wood cabinets shall be Architectural Cabinets, Custom grade constructed in conformance with Section 400 of the Architectural Woodwork Quality Standards and with the details shown on the drawings. Unless otherwise shown or specified, cabinets shall be of the manufacturer's standard size, type, or design. Construction shall be of the reveal or flush overlay type. Shelves shall be fixed or adjustable type as shown. Exposed surface of cabinet work shall be red oak, and shall be plain sliced or rotary cut veneer, or plane sawn or quarter sawn if solid wood is provided. Both wall and base cabinet assemblies may consist of individual units joined into continuous sections as indicated. Fastenings shall be accomplished to permit removal and replacement of individual units without affecting the remainder of the installation. Counters shall be provided with watertight sink rim. Cabinets shall be of the indicated configuration. Doors and drawers shall be removable and shall be equipped with position stops to avoid accidental complete withdrawals. Under no circumstances shall particle board be utilized as core material within any millwork item.

Raised panel doors, as indicated, shall be custom grade, as defined by section 500C of the Architectural Woodwork Quality Standards and shall be compatible with details as shown.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The

following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

SD-13 Certificates

Wood Cabinets; FIO.

Certificates shall certify cabinets are constructed in conformance with AWI Standards.

SD-04 Drawings

Wood Cabinets; FIO.

Shop drawings, catalog cuts, and descriptive material shall be submitted. Drawings shall show each type of cabinet and related items and shall clearly indicate the complete layout of the cabinets and accessories, and pertinent details of construction, fabrication, and attachments.

SD-13 Samples

Wood Cabinets; GA.

Samples to be submitted for approval with the shop drawings shall include the items listed below. In lieu of individual samples, complete minimum size cabinets may be furnished as samples. Mockup units are not acceptable.

Countertop and back splash - One section, 100 mm wide, containing both.

Door and drawer front - One of each, with hardware mounted, finished as required.

## 2 PRODUCTS

### 2.1 FINISH

#### 2.1.1 Wood Cabinets

Wood cabinets shall be provided with a factory-applied durable natural finish in accordance with Section 1500 of the AWI Architectural Woodwork Quality Standards System No. TR-1, TR-2, TR-4, or TR-6. Colors and stains shall be as indicated.

#### 2.1.2 Plastic Laminate Sheet

Design, color, and finish shall be as indicated in Section 09915 - COLOR SCHEDULE.

### 2.2 HARDWARE

Hardware shall conform to ANSI A156.9 for residential applications and shall be standard with the manufacturer. Exposed hardware shall be finished as shown in SECTION 09915 - Color Schedule.

## 2.3 COUNTERTOPS AND BACK SPLASH

### 2.3.1 General

Countertop and back splash shall be constructed of 19 mm panel. Edging and trim shall consist of plastic laminate cut and fitted to all exposed edges, unless shown otherwise.

### 2.3.2 Plastic Laminates

Plastic laminate shall conform to NEMA LD 3. Adhesive shall conform to FS MMM-A-130, Type I. Continuous sheets of longest lengths practicable shall be provided. Joints in surface sheeting shall be tight and flush and held to a practicable minimum. When the countertop and back splash are two separate units, GP50 plastic laminate shall be used. When the countertop and back splash are one unit, PF42 plastic laminate shall be used. For fully formed and cove-type countertops, the post-forming plastic laminate shall not be bent to a radii smaller than the limit recommended by the plastic manufacturer.

### 2.3.3 Sink Rims:

Sink rims shall be of the corrosion-resisting steel clamping type, sized to the sink, and a standard product of a manufacturer regularly producing this type of equipment.

### 2.3.4 Backer Sheets:

Backer sheets of high pressure plastic laminate Grade BK20 shall be applied to the underside of all core material.

## 3 EXECUTION

### 3.1 INSTALLATION

Wall and base cabinets shall be installed in accordance with Section 1700-B of the AWI Architectural Woodwork Quality Standards and shall be attached to the walls or floors with suitable devices to securely anchor each unit. Countertops, accessories and hardware shall be installed as indicated. Closer and filler strips and finish moldings shall be provided as required. Prior to final acceptance, the Contractor shall align all doors, adjust all hardware, and leave cabinets in a clean and neat condition.



## SECTION 07111

## ELASTOMERIC MEMBRANE WATERPROOFING

## 1 GENERAL

At the option of the Contractor, elastomeric membrane waterproofing as specified herein or bituminous waterproofing as specified in Section 07112 - BITUMINOUS WATERPROOFING, may be applied where waterproofing system is shown on the drawings.

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 297	(1993) Rubber Products - Chemical Analysis
ASTM D 412	(1992) Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension
ASTM D 471	(1995) Rubber Property - Effect of Liquids
ASTM D 624	(1991) Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
ASTM D 1004	(1994a) Initial Tear Resistance of Plastic Film and Sheeting
ASTM D 1171	(1994) Rubber Deterioration-Surface Ozone Cracking Outdoors or Chamber (Triangular Specimen)
ASTM D 4637	(1987) Vulcanized Rubber Sheet Used in Single-Ply Roof Membrane
ASTM E 96	(1995) Water Vapor Transmission of Materials
ASTM E 154	(1988; R 1993) Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover
ASTM G 21	(1990) Determining Resistance of Synthetic Polymeric Materials to Fungi

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

## SD-04 Drawings

Waterproofing System; FIO.

Detail drawings showing size of sheets, position of sheets and splices, flashing and termination details, and expansion joint details.

## SD-06 Instructions

Installation; FIO.

Manufacturer's instructions for installation of the elastomeric membrane, including procedures for preparing the membrane for use, flashing, and splicing. Instructions shall include recommended or required protective covering and procedures for safe handling and use of cleaners, adhesives, and sealants.

## SD-13 Certificates

Materials; FIO.

Certificates of compliance attesting that the materials meet specification requirements. Certificates may show qualification of the identical compound in the specified test.

## 1.3 DELIVERY, STORAGE, AND HANDLING

Materials shall be delivered to the job site in unopened containers bearing the manufacturer's name, brand name, and description of contents. Membrane, flashing, and adhesives shall be stored in clean, dry areas. Storage temperature for adhesives shall be between 16 and 27 degrees C. Protection board shall be stored flat and off the ground.

## 2 PRODUCTS

## 2.1 MATERIALS

Adhesives, mastics, cements, tapes, and primers shall be as recommended by the membrane manufacturer and shall be compatible with the material to which they are to be bonded.

## 2.1.1 Performance Requirements

All membranes shall meet the following requirements when tested by the referenced ASTM standards:

## ASTM E 154

Puncture Resistance

178 N, (min.)

## ASTM E 96, Procedure B

Water Vapor Transmission at  
27 degrees C Permeance  
(max.)

14.4 ng per Pa per sec per  
sq. meter (0.25 perms)

## ASTM G 21 or ASTM E 154

Resistance to Soil Bacteria or Fungi

No sustained growth or  
discoloration after 21 days

## 2.1.1.1 Butyl Rubber

Thickness, plus or minus 10 percent	1.5 mm
ASTM D 297 Specific Gravity	1.2 plus or minus 0.05
ASTM D 412 Tensile Strength	8275 kPa (min.)
ASTM D 624 Elongation	300 percent (min.)
ASTM D 624 Tear Resistance (min.)	21 900 Newtons per m
ASTM D 471 Water Absorption 168 hours @ 40 degrees C	plus 2 percent (max.)
ASTM D 1171 Ozone Resistance 50 pphm in air 100 hours @ 40 degrees C	20 percent

## 2.1.1.2 Plastic Elastomeric Sheeting

Membrane shall be a minimum of 1.42 mm thick and shall meet the following requirements:

ASTM D 412, Die C Textile Strength	1520 kPa (min.)
ASTM D 412, Die C Elongation	250 percent (min.)
ASTM D 1004 Tear Resistance	61 300 Newtons per m (min.)

## 2.1.1.3 Composite Self-Adhering Membrane

Membrane shall be a polymeric sheeting integrally bonded to rubberized asphalt with a minimum thickness of 1.5 mm.

## 2.1.1.4 Chlorinated Polyethylene (CPE) Sheeting

Membrane shall be uncured chlorinated polyethylene, synthetic elastomeric sheeting of 1 mm nominal thickness.

## 2.1.1.5 Chloroprene

Chloroprene membrane shall conform to ASTM D 4637, Type II, Grade 1, Class U, 1.5 mm minimum thickness.

### 2.1.2 Protection Board

Protection board for waterproofing membrane shall be 13 mm minimum asphalt plank, 13 mm fiberboard, 25 mm thick polystyrene foam insulation or premolded bituminous protection board; 3 mm thick for vertical surfaces, and 6 mm thick for horizontal surfaces.

## 2.2 ACCESSORIES

Flashing, counterflashing, expansion joint covers and corner fillets shall be as recommended by the membrane manufacturer.

## 3 EXECUTION

### 3.1 PREPARATION

Surfaces to which waterproofing is to be applied shall be clean, smooth, and free from deleterious materials and projections. Holes, honeycomb, cracks, or cavities shall be pointed or filled and finished flush with portland cement mortar. Top surfaces of projecting masonry or concrete ledges below grade, except footings, shall be beveled. Before waterproofing is applied, the surfaces to be covered shall be swept to remove all dust and foreign matter. Concrete surfaces shall be cured 30 days prior to receiving elastomeric waterproofing and shall not be cured with compounds containing wax or oil. Masonry surfaces to be waterproofed shall have joints struck flush.

### 3.2 APPLICATION

Waterproofing shall not be applied to wet surfaces. The ambient and surface temperatures shall be above 4.5 degrees C during application. Membrane under slabs shall be carried up abutting vertical surfaces to the level of finish of floor or to within 13 mm of the top edge of base where base is shown and cemented solid to the substrate. Membrane shall not be continuous through walls, floors, piers, and columns unless otherwise shown. Concrete surfaces shall be primed to receive the membrane. Membranes shall be handled and installed in accordance with the approved installation instructions. Primers, adhesives, and mastics shall be applied in accordance with the membrane manufacturer's printed instructions. Laps shall be oriented so that water will flow over the lap, and not into them. As soon as the mastic is fully set and dry, joints shall be checked. Where any openings or fishmouths appear, joints shall be resealed and rerolled. Wrinkles and buckles shall be avoided in applying membrane and joint reinforcement. Nonadhering membranes shall be unrolled and allowed to remain flat for at least 2 hours before application. Membranes shall be drawn tight during installation without stretching. Self-adhering membrane shall be installed by removing the release sheets on the back of the membrane and applying the tacky surface onto the primed surface. Laps and splices shall be sealed prior to completion of a day's work.

#### 3.2.1 Butyl Rubber

Each sheet shall be lapped at sides and ends a minimum of 150 mm over the preceding sheet. Lap and splice areas of membrane shall be cleaned with heptane, hexane, or white gasoline. Unvulcanized compounded butyl tape, 150 mm wide shall be applied between lapped splices so that the tape extends approximately 6 mm beyond the exposed sheeting edge. The tape shall be

rolled firmly into place as it is applied. Tape backing shall be removed and the lapped sheeting rolled or pressed into place. Splicing adhesive shall be applied to the lapped area 90 mm on either side of the lapped edge. The splice adhesive shall be allowed to dry thoroughly and the lap reinforced with 150 mm wide unvulcanized compounded butyl tape. Full contact shall be made for all lap areas. Corner splices and flashing overlaps shall be reinforced with a 300 mm wide strip of membrane over one layer of butyl tape or with a prefabricated corner of butyl rubber.

### 3.2.2 Plastic Elastomeric Sheeting

Sheeting shall be applied in sections no longer than 5400 mm. Each sheeting shall be lapped at sides and ends a minimum of 150 mm over the preceding sheet. Lap splices shall be reinforced with 300 mm wide strips of plastic sheeting or as recommended in the approved installation instructions. Lap and splices shall be sealed in a full bed of adhesive at the rate recommended by the manufacturer of the material. Sheeting and joint strips shall be rolled with 150 mm rubber hand roller on vertical] surfaces.

### 3.2.3 Composite Self-Adhering Membrane

On vertical surfaces, membrane shall be applied in lengths up to 2400 mm starting at the bottom. Each sheet shall be lapped at edges and ends a minimum of 65 mm over the preceding sheets. The membrane shall be rolled to adhere with the substrate. Corners and joints shall be double-covered by first applying a 300 mm width of membrane centered along the corner or joint. Inside and outside corners shall then be covered with membrane. Exposed termination edges of membrane on horizontal or vertical surfaces shall be finished with a troweled bead of mastic. Mastic shall be applied around termination edges of membrane and around drains and projections. Mastic shall be applied at the termination of each day's work.

### 3.2.4 Chlorinated Polyethylene (CPE) Sheeting

Sheets shall be lapped at edges and ends a minimum of 65 mm over the preceding sheet. All horizontal membranes shall overlap vertical surfaces by at least 75 mm.

### 3.2.5 Chloroprene Rubber Sheeting

Each sheet shall overlap the previously installed sheet by a minimum of 75 mm. Sheet shall be folded lengthwise to expose one half of the underside of the sheet for cleaning the sheet with cleaner recommended by the manufacturer. Adhesive shall be applied to sheet and substrate. Two coats of adhesive are required on the substrate with 1/2 hour between coats. Sheet shall not be bonded to substrate until adhesive does not come off at a dry finger touch. Chalk lines or masking tape shall be used as guides for adhesive application and positioning sheets. After adhesive has dried, sheet shall be folded back onto the substrate or previously applied sheet membrane. Membrane shall be rolled to obtain complete adhesion. The exposed edge of each sheet shall be further sealed with a fillet-shaped bead of adhesive, tooled to obtain positive contact with the surface of both sheets.

### 3.3 TESTS

When required, and after the system is cured, the membranes on horizontal surfaces shall be tested by flooding the entire waterproofed area with a minimum of 50 mm head of water for a period of 24 hours. There shall be no water added after the start of the period. Water level shall be measured at the beginning and at the end of the 24 hour period. If the water level falls, remove the water and inspect the waterproofing membrane. Leak sites shall be marked, dried and repaired, and the test shall be repeated.

### 3.4 PROTECTION

Horizontal applications of membrane shall be protected from traffic during installation. No equipment shall be allowed directly on the membrane. Plywood, or similar material, overlayment shall be provided for wheel-ways. Walkways shall be provided where heavy traffic from other trades is expected. Materials shall not be stored on the membrane. A protective covering shall be installed over the membrane immediately after installation or testing. If membrane is to be exposed, a temporary covering shall be applied to protect the membrane until the protection board is installed.

#### 3.4.1 Projections

Projections passing through membrane shall be flashed as recommended by the manufacturer of the waterproofing membrane.

#### 3.4.2 Counterflashing

Waterproofing connecting with work exposed to the weather shall be counterflashed to form a watertight connection. Upper edge of membrane waterproofing and protective covering shall be counterflashed.

#### 3.4.3 Expansion Joints and Fillets

Expansion joints and corner fillets shall be installed as recommended by the manufacturer of the waterproofing membrane.

#### 3.4.4 Vertical Membrane Waterproofing

Waterproofing shall be protected with a 13 mm minimum fiberboard, 13 mm asphalt-impregnated fiberboard, 25 mm polystyrene foam insulation or 3 mm compatible water-resistant (bitumen type) protection board. Edges of protection shall be butted, and exposed surfaces shall be covered by a coating of bitumen.

#### 3.4.5 Horizontal Membrane Waterproofing

Waterproofing shall be covered with portland cement mortar not less than 20 mm thick, uniformly placed and allowed to set before subsequent construction is installed.

## SECTION 07112

## BITUMINOUS WATERPROOFING

## 1 GENERAL

At the option of the Contractor, bituminous waterproofing as specified herein or elastomeric membrane waterproofing as specified in Section 07111 - ELASTOMERIC MEMBRANE WATERPROOFING, may be applied where waterproofing system is shown on the drawings.

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 208	(1995) Cellulosic Fiber Insulating Board
ASTM D 41	(1994) Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
ASTM D 173	(1994) Bitumen-Saturated Cotton Fabrics Used in Roofing and Waterproofing
ASTM D 449	(1989; R 1994) Asphalt Used in Dampproofing and Waterproofing
ASTM D 1327	(1994) Bitumen-Saturated Woven Burlap Fabrics Used in Roofing and Waterproofing
ASTM D 1668	(1994) Glass Fabrics (Woven and Treated) for Roofing and Waterproofing
ASTM D 4586	(1993) Asphalt Roof Cement, Asbestos Free

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

SD-01 Data

Reinforcing Fabric; FIO. Protection Board; FIO.

Manufacturer's data including technical information which indicates full compliance with this section.

## SD-06 Instructions

Application; FIO.

Manufacturer's installation instructions, before delivery of materials to the site. Instructions shall specify acceptable range of asphalt application temperatures and the maximum temperature for holding asphalt in a heated condition.

## SD-13 Certificates

Materials; FIO.

Certificates from manufacturer attesting that asphalt manufactured and shipped to jobsite meets the specified requirements.

## 1.3 QUALIFICATIONS

Work shall be performed by skilled laborers thoroughly experienced in the type of bituminous waterproofing work specified to meet the requirements of the contract.

## 1.4 DELIVERY, STORAGE AND HANDLING

Waterproofing materials shall be delivered to the project site in the original sealed containers bearing the name of the manufacturer, contents and brand name. Asphalt shall be protected from freezing in a weathertight enclosure. Reinforcement fabrics shall be protected from moisture damage and moisture absorption in a weathertight enclosure or shall be stored off the ground on pallets, and covered on top and all sides with breathable-type canvas tarpaulins. Plastic sheets cause condensation buildup and therefore shall not be used to cover waterproofing materials. Damaged or deteriorated materials shall be removed from project site.

## 2 PRODUCTS

## 2.1 ASPHALT WATERPROOFING

## 2.1.1 Primer

Primer for hot-applied asphalt waterproofing shall conform to ASTM D 41, asbestos-free, non-fibrated, manufactured with highly ductile soft asphalts and selected hydrocarbons.

## 2.1.2 Above-Grade Hot-Applied Asphalt

For above-grade applications where asphalt will not be exposed to temperatures exceeding 50 degrees C, hot-applied asphalt for membrane waterproofing system shall conform to ASTM D 449, Type II. For above-grade applications where asphalt will be exposed to sunlight and temperatures exceeding 50 degrees C, hot-applied asphalt shall conform to ASTM D 449, Type III.



### 2.1.3 Below-Grade Hot-Applied Asphalt

Hot-applied asphalt for below-grade applications shall conform to ASTM D 449, Type I, asbestos-free, manufactured from crude petroleum, suitable for use with membrane waterproofing systems.

### 2.1.4 Reinforcement Fabrics

#### 2.1.4.1 Cotton Fabrics

Cotton fabrics shall be woven entirely of cotton conforming with ASTM D 173, thoroughly and uniformly saturated with asphalt.

#### 2.1.4.2 Woven Burlap Fabrics

Woven burlap fabrics shall be composed of 100 percent jute fiber and two cotton threads at each selvage conforming with ASTM D 1327, thoroughly and uniformly saturated with asphalt. The fabric mesh shall not be completely closed or sealed by the process of saturation. Sufficient porosity shall be maintained to allow successive moppings of the plying asphalt to seep through. The surface shall not be coated or covered with talc or any other substances that will interfere with the adhesion between fabric and plying asphalt. The fabric surface shall be uniformly smooth and free of irregularities, folds and knots. The finished woven burlap fabrics shall be free of ragged edges, untrue edges, breaks or cracks, and other visible external defects.

#### 2.1.4.3 Glass Fabrics

Glass fabrics shall conform to ASTM D 1668 Type I, asphalt-treated woven glass waterproofing fabrics coated with asphalt.

### 2.1.5 Flashing Cement

Flashing cement shall conform to ASTM D 4586, Type I, trowel grade, asbestos free, manufactured from asphalts characterized as adhesive, healing and ductile.

## 2.2 INSULATION BOARDS

Insulation boards shall conform to ASTM C 208 cellulosic fiber boards, construction grade, 13 mm thick, fibrous-felted homogeneous panel. Insulation boards shall be manufactured from ligno-cellulosic fibers (wood or cane) by a felting or molding process, asphalt-saturated or coated, with a density of 49 to 151 kg per square meter. Surfaces of insulation boards shall be free of cracks, lumps, excessive departure from planeness, or other defects that adversely affect performance.

## 3 EXECUTION

### 3.1 SURFACE PREPARATION

Surfaces scheduled for bituminous waterproofing shall be prepared in accordance with waterproofing manufacturer's recommendations. Surface preparation shall be approved prior to waterproofing application.

### 3.1.1 Protection of Surrounding Areas

Before starting the waterproofing work, the surrounding areas and surfaces shall be protected from spillage and migration of asphalt onto other work. Drains and conductors shall be protected from clogging with asphalt.

### 3.1.2 Masonry Surfaces

Surfaces shall be free of oil, grease, dirt, laitance, loose material, frost, debris and other contaminants. Mortar joints shall be flush and free of extraneous mortar and chipped or broken masonry.

### 3.1.3 Concrete Surfaces

Surfaces shall be properly cured, free of form release agents, oil, grease, dirt, laitance, loose material, frost, debris and other contaminants. Form ties shall be cut flush with surface. Sharp protrusions and form match lines shall be removed. Holes, voids, spalled areas and cracks which can damage waterproofing materials shall be repaired. Rough surfaces shall be parged with a well-adhering coat of cement mortar.

### 3.1.4 Metal Surfaces

Surfaces shall be dry and be free of rust, scale, loose paint, oil, grease, dirt, frost and debris.

## 3.2 HOT-APPLIED ASPHALT WATERPROOFING

Asphalt waterproofing shall be applied when the ambient temperature is 4 degrees C or above. Heating kettles and tanks shall be provided with automatic thermostatic control capable of maintaining asphalt temperature. Controls shall be calibrated and maintained in working order for duration of work. At time of application, asphalt shall not be heated above the equiviscous temperature (EVT) recommended by manufacturer. Immediately before use, temperature shall be measured with a portable thermometer at the point of application. EVT and flashpoint temperatures of asphalt in kettle shall be conspicuously posted on kettle. Asphalt with a temperature not conforming to the manufacturer's recommendations shall be returned to the kettle. Asphalt overheated by more than 10 degrees C for more than 1 hour shall be removed from site.

### 3.2.1 Below-Grade Wall Waterproofing

Waterproofing for foundation walls shall consist of a 2-ply hot-applied asphalt membrane system. Fabrics shall be installed using the "shingle" method. Joints shall be caulked prior to primer applications. Primer shall be applied at a rate of 0.2 liters per square meter. Fabrics shall be overlapped at ends and staggered a minimum 480 mm for 2-ply system. End-to-end taping is not acceptable. Each fabric shall be firmly embedded into a solid uniform coating of hot asphalt at a rate of 0.98 kg per square meter by pressing with broom. Fabrics shall not touch fabrics. Hot asphalt shall penetrate each fabric to provide the required adhesion. Asphalt between fabrics shall not be excessive to prevent slippage. Waterproofing system consisting of two or more fabrics shall be provided with fabric reinforcement at corners, angles, over construction joints, and in locations where waterproofing fabrics are subject to unusual stress.

### 3.3 CLEAN-UP

Surfaces of other work which are stained with waterproofing materials shall be cleaned with a cleaner recommended by waterproofing manufacturer.

### 3.4 PROTECTION OF COMPLETED WORK

#### 3.4.1 Floor Waterproofing

The completed waterproofing work shall be protected from damage during and after construction. Protective covering shall be placed immediately before proceeding with the work which will conceal the waterproofing.

#### 3.4.2 Wall Waterproofing

Waterproofing against which backfill is to be placed shall be protected with a single layer of insulation board. Insulation boards shall be pressed into the final mopping while the asphalt is still hot, with edges of boards placed into moderate contact and joints staggered. For two-layer installation, joints in second layer shall be staggered over joints in first layer. Where surfaced insulation board is used, the surfaced side shall face outward. Boards shall be carefully and neatly fitted around projections, and shall cover the entire surface of the waterproofing materials. Waterproofing system not covered with protection boards shall be protected to prevent damage from subsequent building operations. Installed boards shall not remain exposed at the end of a work day.

## SECTION 07160

## 15# FELT DAMPPROOFING

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 226 (1989) Asphalt-Saturated  
Organic Felt Used in Roofing and  
Waterproofing

## 2 PRODUCTS

## 2.1 MOISTURE BARRIER

The moisture barrier shall be 6.8 Kg (15-lb) asphalt-saturated felt conforming to ASTM D 226, Type I (No. 15) or other similar materials as approved by the Contracting Officer.

## 3 EXECUTION

Dampproofing shall be applied behind veneer masonry surfaces at the locations shown on the drawings.

## 3.1 APPLICATION

The moisture barrier dampproofing shall be installed horizontally and shingled with each sheet lapped not less than 6 inches over the sheet below. Vertical end joints shall be lapped not less than 150 mm and shall be staggered. Attachment of the moisture barrier shall be with staples spaced not greater than 16 inches on center or as required by the manufacturer.

## 3.2 PROTECTION

The completed dampproofing work shall be protected from damage during and after construction.

## SECTION 07240

## EXTERIOR INSULATION AND FINISH SYSTEM

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 117	(1994) Operating Salt Spray (Fog) Testing Apparatus
ASTM C 67	(1994) Sampling and Testing Brick and Structural Clay Tile
ASTM C 578	(1992) Rigid, Cellular Polystyrene Thermal Insulation
ASTM C 920	(1987) Elastomeric Joint Sealants
ASTM C 1149	(1990) Self-Supported Spray-Applied Cellulosic Thermal or Acoustical Insulation, or Both
ASTM D 968	(1993) Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM E 84	(1995) Surface Burning Characteristics of Building Materials
ASTM E 96	(1994) Water Vapor Transmission of Materials
ASTM E 330	(1990) Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference
ASTM G 23	(1995) Operating Light-Exposure Apparatus (Carbon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials
ASTM G 53	(1993) Operating Light- and Water-Exposure Apparatus (Fluorescent UV-Condensation Type) For Exposure of Nonmetallic Materials

## EIFS INDUSTRY MEMBERS ASSOCIATION (EIMA)

EIMA 101.86	(1992; Rev May 1994) Resistance of Exterior Insulation and Finish Systems to the Effects of Rapid Deformation (Impact)
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## INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS (ICBO)

ICBO-102S94

(1994) Uniform Building Code Standards:  
Uniform Building Code, Vol. III

## 1.2 DESCRIPTION

The exterior insulation and finish system (EIFS) shall be a job-fabricated exterior wall covering consisting of insulation, reinforcing fabric, base coat, finish coat, and accessories. The system shall be the standard product of a manufacturer regularly engaged in furnishing exterior insulation and finish systems and shall be installed by an applicator approved by the system manufacturer. EIFS shall be polymer base, Class PB and shall be color and finish as indicated in Section 09915 - COLOR SCHEDULE.

## 1.3 PERFORMANCE REQUIREMENTS

## 1.3.1 Test Specimens

Unless otherwise noted, the test specimens shall consist of reinforcement, base coat and finish coat applied in accordance with the manufacturer's printed recommendations to an insulation board common to the system. These test specimens shall be suitably sized for the apparatus used and be allowed to cure for a minimum of 28 days prior to testing.

## 1.3.1.1 Flame Spread

Flame spread test samples consist of base coat, fabric and finish coat, mounted on a non-combustible substrate. When tested in accordance with ASTM E 84, the samples shall have a flame spread rating of 25 or less.

## 1.3.1.2 Full Scale Wall Fire Test

Full scale wall fire test specimens shall include the complete system with no less than 100 mm of insulation. Test shall be performed in accordance with ICBO-102S94, Section 17-6. The specimen shall not contribute to significant or horizontal flame spread.

## 1.3.2 Impact Test

The exterior insulation and finish system shall have been tested in accordance with EIMA 101.86 using a specimen consisting of cured finish system over 25 mm thick insulation with base coat and reinforcing fabric in a complete assembly typical of the project application. Standard Impact Specimen shall withstand an impact of 4.4 - 8.6 kilo-newtons/meter. High Impact Specimen shall withstand an impact of greater than 26.2 kilo-newtons/meter.

## 1.3.3 Structural Performance Test

The system shall have been tested in accordance with ASTM E 330 to minimum positive and negative pressures of 0.96 kPa. Test panels shall be 1.2 m by 1.2 m minimum, consisting of the typical system assembly.

#### 1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

##### SD-06 Instructions

Exterior Insulation and Finish System; FIO.

Two copies of manufacturer's standard printed instructions for installation of the system. Instructions shall include manufacturer's recommended details for corner treatment, jambs, sills, openings, joints and other special applications.

##### SD-09 Reports

Exterior Insulation and Finish System; FIO.

Test Reports indicating that the system complies with the specified performance tests. Tests shall be by an approved, independent testing laboratory.

##### SD-14 Samples

Exterior Insulation and Finish System; GA.

Two samples of each exterior insulation and finish system. Each sample shall be 300 mm square, minimum, and shall be identical to the proposed installation in thickness, color, texture, insulation and workmanship.

##### SD-08 Statements

Manufacturer's Approval and License; FIO.

Statement from manufacturer attesting that the applicator is approved and licensed to install the system.

#### 1.5 DELIVERY AND STORAGE

Materials shall be delivered to the jobsite in their original unopened packages, clearly marked with the manufacturer's name, brand name, and description of contents. Storage shall be in accordance with the manufacturer's recommendations in a clean, dry, well-ventilated area. Stored materials shall be protected from sunlight, and kept away from excessive heat. Coating materials which would be damaged by freezing shall be kept at a temperature not less than 4 degrees C. Insulation board shall not be exposed to flame or other ignition sources.

## 2 PRODUCTS

### 2.1 GYPSUM SHEATHING

Gypsum sheathing is specified in Section 06100 - ROUGH CARPENTRY.

## 2.2 ADHESIVE

Adhesive shall be the manufacturer's standard product, including primer as required, and shall be compatible with the substrate to which the system is applied.

## 2.3 INSULATION

Insulation shall conform to ASTM C 578, type as recommended by the system manufacturer and shall be compatible with other system components. Insulation shall be aged a minimum of 6 weeks by air drying, or equivalent prior to installation. Insulation shall be a standard product of the manufacturer and shall be factory marked with the manufacturer's name or trade mark, the material specification number, the R-value at 24 degrees C, and thickness. Thickness of insulation shall be based on specified R-value, but no single layer shall be less than 19 mm thick. Boards shall be marked individually. The thermal resistance of insulation in the system shall be not less than the R-value shown on the drawings. Insulation for Class PM and insulation extending below grade shall be restricted to a low water vapor permeability grade of extruded polystyrene (type IV or X).

## 2.4 BASE COAT

Base coat shall be the manufacturer's standard product and shall be compatible with the finish coat.

## 2.5 REINFORCING FABRIC

Reinforcing fabric shall be balanced, open weave, glass fiber fabric made from twisted multi-end strands specifically treated for compatibility with the other materials of the system.

## 2.6 MECHANICAL ANCHORS

Mechanical anchors shall be as recommended by the system manufacturer.

## 2.7 FINISH COATING

Finish coating shall be manufacturer's standard product, uniform in color and conforming to the following requirements. Specimens for tests shall have been cured for a minimum of 28 days and shall be in accordance with Table I at the end of the section.

## 2.8 SEALANT

Sealant shall meet requirements of ASTM C 920, Class 25, and shall be compatible with the finish system. Type, Grade, and Use shall be as recommended by both the sealant manufacturer and the system manufacturer. When required, primer, bond breaker and backstop shall be non-staining, and as recommended by the sealant manufacturer and the system manufacturer.

## 2.9 ACCESSORIES

Accessories shall conform to the recommendations of the system manufacturer and shall include trim, edging, anchors, sealant and filler rod required for proper installation of the system.



### 3 EXECUTION

#### 3.1 SURFACE PREPARATION

Surface shall be free of oil, loose materials or protrusions which will interfere with the system installation.

#### 3.2 ENVIRONMENTAL CONDITION

Unless a higher temperature is required by the system manufacturer, the ambient air temperature shall be 4 degrees C or greater and rising at the time of installation of the system and shall be predicted to remain at 4 degrees C or greater for at least 24 hours after installation.

#### 3.3 EXTERIOR SHEATHING

Sheathing board shall be attached to metal studs with self-tapping wafer-head, corrosion resistant screws, nailed to wood studs, or secured to concrete or masonry with approved fasteners. Screws and nails for application of the board shall be spaced not more than 200 mm on each supporting member, and fasteners into concrete or masonry shall be spaced not more than 300 mm apart horizontally and vertically. Fasteners shall be more closely spaced when required for negative wind load resistance. Edges and ends of boards shall be butted snugly with vertical joints staggered to provide full and even support for the insulation.

#### 3.4 INSULATION BOARD AND REINFORCING FABRIC

Unless otherwise specified by the system manufacturer, insulation boards shall be placed horizontally from a level base line. Vertical joints shall be staggered and insulation boards interlocked at corners. Joints of insulation shall be butted tightly. Surfaces of adjacent insulation boards shall be flush at joints. Joints of insulation shall be offset from substrate joints. Reinforcing glass fabric shall be installed in accordance with the manufacturer's instructions.

#### 3.5 ADHESIVE SYSTEM

Primer (if required by the manufacturer) and adhesive shall be prepared and applied with a stainless steel trowel to substrate in accordance with the manufacturer's instructions. The pattern of the reinforcing fabric shall not be visible. Adhesive used with Class PM must be supplemented with mechanical fasteners. Adhesive shall be used without fasteners only with Class PB system and when recommended by the manufacturer.

#### 3.6 BASE COAT

Base coat shall be mixed in accordance with the manufacturer's instructions and applied to insulated wall surfaces, trowelling the material into the reinforcing fabric in a tight coat and doubling back to provide complete coverage of the reinforcing fabric, panel joints and fasteners. Base coat may be used to level out surface areas when permitted by the manufacturer.

#### 3.7 FINISH COATING

Finish coating shall be applied and leveled in one operation. Final texture shall be obtained by trowels, floats, or by spray application as necessary

to achieve the required finish. Finish surfaces shall be plane, with no deviation greater than 6 mm when tested with a 3 m straightedge.

### 3.8 SEALANT

Edges of the exterior insulation and finish system shall be sealed at openings as recommended by the system manufacturer.

TABLE I

TEST	METHOD	RESULTS
Abrasion Resistance	ASTM D 968	500 liters of sand- slight - smoothing - no loss of film integrity.
Accelerated weathering water exposure	ASTM G 23 or ASTM G 53	2000 hours. No Light deterioration
Mildew-fungus resistance	ASTM C 1149	Expose for 28 days at 95 percent RH, 32 degrees C temperature. No growth of mildew or fungus.
Salt spray resistance	ASTM B 117	Withstand 300 hours - No deleterious effects.
Water vapor	ASTM E 96	Not more than 13 grams per square meter an hour.
Absorption-freeze (Pre-weighed 100 mm by 200 mm specimens; 25 mm insulation	ASTM C 67	After 50 cycles - Total weight gain of not more than 6.2 grams. No  50 Cycles: 20 hrs at -9C; 4-hr. thaw. No splitting, cracking, or checking.

## SECTION 07250

## SPRAY-APPLIED FIREPROOFING

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 119	(1995a) Fire Tests of Building Construction and Materials
ASTM E 605	(1993) Thickness and Density of Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members
ASTM E 736	(1992) Cohesion/Adhesion of Sprayed Fire-Resistive Materials Applied to Structural Members
ASTM E 759	(1992) Effect of Deflection on Sprayed Fire-Resistive Material Applied to Structural Members
ASTM E 760	(1992) Effect of Impact on Bonding of Sprayed Fire-Resistive Material Applied to Structural Members
ASTM E 761	(1992) Compressive Strength of Sprayed Fire-Resistive Material Applied to Structural Members
ASTM E 937	(1993) Corrosion of Steel by Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members
ASTM E 1042	(1992) Acoustically Absorptive Materials Applied by Trowel or Spray
ASTM G 21	(1990) Determining Resistance of Synthetic Polymeric Materials to Fungi

## UNDERWRITERS LABORATORIES (UL)

UL-05	(1996; Supple) Fire Resistance Directory (3 Vol.)
UL 263	(1992) Fire Tests of Building Construction and Materials

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

### SD-01 Data

Fireproofing Material; GA.

Data identifying performance characteristics of fireproofing material. Data shall include recommended application requirements and indicate thickness of fireproofing that must be applied to achieve each required fire rating.

### SD-09 Reports

UL Test Assembly; FIO.

Reports and test records, attesting that the fireproofing material conforms to the specified requirements. Each test report shall conform to the report requirements specified by the test method.

Field Tests; FIO.

Test reports documenting results of tests on the applied material in the project. Report shall include defects identified, repair procedures, and results of the retests when required.

### SD-13 Certificates

Installer Qualifications; FIO.

Manufacturer's certification that each listed installer is qualified and trained to install the specified fireproofing. Evidence that each fireproofing installer has had a minimum of 3 years experience in installing the specified type of fireproofing.

Surface Acceptability; FIO.

Manufacturer's certification that surfaces to be protected have been inspected and are acceptable to receive spray-applied fireproofing. The statement shall list the structural members and the areas that have been inspected and certified.

Manufacturer's Inspection; FIO.

Manufacturer's certification that the spray-applied fireproofing in the entire project complies with the manufacturer's criteria and recommendations.

### SD-14 Samples

Spray-Applied Fireproofing; FIO.

One sample panel, 450 mm square, for each specified type of fireproofing. Also, a designated sample area of not less than 9 square meters shall be

prepared. Sample area shall be representative of typical installation of fireproofing including metal decks, beams, columns and attachments. Equipment, materials and procedures used in the sample area shall be the same as, or representative of that to be used in the work. The sample area shall be approved prior to proceeding with fireproofing work in any other area. The approved sample area shall be used as a reference standard for applied fireproofing material. Sample area shall remain in place and open to observation until all spray-applied fireproofing is completed and accepted, at which time it may become part of the work.

### 1.3 DELIVERY AND STORAGE

Packaged material shall be delivered in the original unopened containers, marked to show the names of the brand and the manufacturer. Fireproofing material shall be kept dry until ready to be used, and shall be stored off the ground, under cover and away from damp surfaces. Damaged or opened containers will be rejected. Material with shelf-life shall be applied prior to expiration of the shelf-life.

### 1.4 ENVIRONMENTAL CONDITIONS

#### 1.4.1 Temperature

Substrate and ambient air temperatures shall be maintained above 4 degrees C during application and for 24 hours before and after application. Relative humidity shall be maintained within the limits recommended by the fireproofing manufacturer.

#### 1.4.2 Ventilation

Adequate ventilation shall be provided to properly dry the fireproofing after application. In enclosed areas, a minimum of 4 air exchanges per hour shall be provided by forced air circulation.

### 1.5 INSTALLER QUALIFICATIONS

Each installer of fireproofing material shall be trained and have a minimum of 3 years experience in the installation of fireproofing of the type specified.

### 1.6 MANUFACTURER'S SERVICES

The manufacturer or his representative shall be onsite prior to, periodically during, and at completion of the application, to provide the specified inspections and certifications; and to ensure that preparations are adequate and that the material is applied according to manufacturer's recommendations and the contract requirements.

### 1.7 FIRE RESISTANCE RATING

Fire resistance ratings shall be in accordance with the fire rated assemblies listed in UL-05. Proposed materials not listed in UL-05 shall have fire resistance ratings at least equal to the UL-05 ratings as determined by an approved independent testing laboratory based on tests specified in UL 263 or ASTM E 119.

## 1.8 EXTENT OF FIREPROOFING

Fireproofing shall not be applied to structural steel and underside of deck in elevator machine room, and steel bearing members in elevator hoistways. All other structural steel, and the underside of steel floor and steel roof decks shall be protected with spray-applied fireproofing to a fire resistance hour-rating as indicated, unless otherwise indicated.

## 2 PRODUCTS

### 2.1 SPRAY-APPLIED FIREPROOFING

Spray-applied fireproofing material, including sealer, shall conform to ASTM E 1042, Class (a), Category A, either Type I or Type II, except that the dust removed shall not exceed 0.027 gram per square meter of fireproofing material applied as specified in the project. Material shall be asbestos free, and shall resist fungus for a period of 28 days when tested in accordance with ASTM G 21.

#### 2.1.1 Dry Density and Cohesion/Adhesion

Fireproofing shall have a minimum ASTM E 605 dry density and ASTM E 736 cohesion/adhesion properties as follows:

##### 2.1.1.1 Concealed Structural Components

Fireproofing for structural components concealed above the ceiling, or within a wall, chase, or furred space, shall have a minimum average applied dry density of 240 kg per cubic meter and a cohesion/adhesion strength of 9.57 kPa.

##### 2.1.1.2 Exposed Structural Components

Fireproofing for exposed structural components, except where otherwise specified or indicated, shall have a minimum applied dry density of 350 kg per cubic meter and a cohesion/adhesion strength of 14.36 kPa.

##### 2.1.1.3 Mechanical Rooms and Storage Areas

Fireproofing for structural components located in mechanical rooms and storage areas shall have a minimum applied dry density of 640 kg per cubic meter and a cohesion/adhesion strength of 19.15 kPa.

#### 2.1.2 Deflection

Spray-applied fireproofing shall not crack, spall, or delaminate when tested in accordance with ASTM E 759.

#### 2.1.3 Bond-Impact

Spray-applied fireproofing material shall not crack, spall or delaminate when tested in accordance with ASTM E 760.

#### 2.1.4 Compressive Strength

The minimum compressive strength shall be 48 kPa when tested in accordance with ASTM E 761.

### 2.1.5 Corrosion

Spray-applied fireproofing material shall not contribute to corrosion of test panels when tested as specified in ASTM E 937.

### 2.2 SEALER

Sealer shall be the type approved by the manufacturer of the fireproofing material and shall be white or green color.

### 2.3 WATER

Water used for material mixing and surface preparation shall be potable.

## 3 EXECUTION

### 3.1 SURFACE PREPARATION

Surfaces to be fireproofed shall be thoroughly cleaned of dirt, grease, oil, paint, loose rust, rolling lubricant, mill scale or other contaminants that will interfere with the proper bonding of the sprayed fireproofing to the substrate. Overhead areas to be fireproofed shall be cleared of all obstructions interfering with the uniform application of the spray-applied fireproofing. Hardware such as support sleeves, inserts, clips, hanger attachment devices and the like shall be installed prior to the application of the fireproofing. Condition of the surfaces shall be acceptable to the manufacturer prior to application of spray-applied fireproofing. Applications listed for use on primed surfaces shall be coordinated with the manufacturer and detailed in submittal item SD-01 Data.

### 3.2 PROTECTION

Surfaces not to receive spray-applied fireproofing shall be covered to prevent contamination by splatter, rebound and overspray. Exterior openings in areas to receive spray-applied fireproofing shall be covered prior to and during application of fireproofing with tarpaulins or other approved material. Surfaces not to receive fireproofing shall be cleaned of fireproofing and sealer.

### 3.3 MIXING

Fireproofing material shall be mixed in accordance with the manufacturer's recommendations.

### 3.4 APPLICATION

#### 3.4.1 Sequence

Prior to application of fireproofing on each floor, the manufacturer shall inspect and approve application equipment, water supply and pressure, and the application procedures. Fireproofing shall be applied to underside of steel roof deck or steel floor assemblies only after respective roof or floor construction is complete. Fireproofing material shall be applied prior to the installation of ductwork, piping and conduits which would interfere with uniform application of the fireproofing. No roof traffic shall be allowed during application and curing period.



### 3.4.2 Application Technique

Water pressure and volume shall be maintained to manufacturer's recommendations throughout the fireproofing application. Fireproofing material shall be applied to the thickness established for the specified fire resistance rating, in accordance with the procedure recommended by the manufacturer, and to a uniform density and texture. Fireproofing material shall not be tamped to achieve the desired density. Sealer shall be applied to all fireproofing.

### 3.5 FIELD TESTS

The applied fireproofing shall be tested in approved locations for density, and cohesion/adhesion force as specified, and for thickness in accordance with ASTM E 605, by an approved independent testing laboratory. Two sets of tests shall be conducted on each floor or 930 square meter area, whichever is less, at the approved locations. Any area showing less than minimum requirements shall be rejected and corrected. Proposed corrective measures, in writing, shall be approved before starting the corrective action. Corrected work shall be retested.

#### 3.5.1 Thickness, Density, Cohesion/Adhesion

Each structural component type shall be tested at floor and roof decks, beams, columns, joists, and trusses. Minimum average thickness shall be as indicated or required by UL-05, is greater. Density and cohesion/adhesion shall be as specified.

#### 3.5.2 Repair

Additional fireproofing material may be added to provide proper thickness. Rejected areas of fireproofing shall be corrected to meet specified requirements by adding fireproofing material to provide the proper thickness, or by removing defects and respraying with new fireproofing material. Repairs shall use same type of fireproofing material as originally applied. Repaired areas shall be retested and reinspected. Fireproofing material shall be applied to voids or damaged areas by hand-trowel, or by respraying.

#### 3.5.3 Manufacturer's Inspection

The manufacturer shall inspect the fireproofing work after the work is completed on each floor or area, including testing, repair and clean-up, and shall certify that the work complies with the manufacturer's criteria and recommendations. Before the sprayed material is covered, and after all of the fireproofing work is completed, including repair, testing, and clean-up; and after mechanical, electrical and other work in contact with fireproofing material has been completed, the manufacturer shall re-inspect the work and certify that the entire project complies with the manufacturer's criteria and recommendations.

## SECTION 07270

## FIRESTOPPING

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 84	(1995a) Surface Burning Characteristics of Building Materials
ASTM E 814	(1994b) Fire Tests of Through-Penetration Fire Stops

## UNDERWRITERS LABORATORIES (UL)

UL-05	(1995; Supple) Fire Resistance Directory
UL 723	(1993; Rev Apr 1994) Test for Surface Burning Characteristics of Building Materials
UL 1479	(1994) Fire Tests of Through-Penetration Firestops

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

## SD-04 Drawings

Firestopping Materials; FIO.

Detail drawings including manufacturer's descriptive data, typical details, installation instructions and the fire-test data and/or report as appropriate for the fire resistance rated construction and location. Submittal shall indicate the firestopping material to be provided for each type of application. When more than 5 penetrations are to receive firestopping, drawings shall indicate location and type of application.

## SD-13 Certificates

Firestopping Materials; FIO.

Certificates attesting that firestopping material complies with the specified requirements. The label or listing of the Underwriters Laboratories will be acceptable evidence. In lieu of the label or listing, a written certificate may be submitted from an approved, nationally recognized testing agency equipped to perform such services, stating that

the items have been tested and conform to the specified requirements and testing methods.

Installer Qualifications; FIO.

Certification stating that installer is qualified and trained to install the specified firestopping material.

Inspection; FIO.

Manufacturer's representative certification stating that firestopping work has been inspected and found to be applied according to the manufacturer's recommendations and the specified requirements.

### 1.3 GENERAL REQUIREMENTS

Firestopping shall consist of furnishing and installing a material or a combination of materials to form an effective barrier against the spread of flame, smoke and gases, and maintain the integrity of fire resistance rated walls, partitions, floors, and ceiling-floor assemblies, including through-penetrations and construction joints. Through-penetrations include the annular space around pipes, tubes, conduit, wires, cables and vents. Construction joints include those used to accommodate expansion, contraction, wind, or seismic movement; firestopping material shall not interfere with the required movement of the joint.

### 1.4 STORAGE AND DELIVERY

Materials shall be delivered in the original unopened packages or containers showing name of the manufacturer and the brand name. Materials shall be stored off the ground and shall be protected from damage and exposure to elements. Damaged or deteriorated materials shall be removed from the site.

### 1.5 INSTALLER QUALIFICATIONS

Installer of firestopping material shall be trained by the manufacturer or the manufacturer's representative, and shall have a minimum of 3 years experience in the installation of firestopping of the type specified.

## 2 PRODUCTS

### 2.1 FIRESTOPPING MATERIALS

Firestopping materials shall consist of commercially manufactured products complying with the following minimum requirements:

#### 2.1.1 Fire Hazard Classification

Material shall have a flame spread of 25 or less, and a smoke developed rating of 50 or less, when tested in accordance with ASTM E 84 or UL 723. Material shall be an approved firestopping material as listed in UL-05.

#### 2.1.2 Toxicity

Material shall be nontoxic to humans at all stages of application.

### 2.1.3 Fire Resistance Rating

Firestopping will not be required to have a greater fire resistance rating than that of the assembly in which it is being placed.

#### 2.1.3.1 Through-Penetrations

Firestopping materials for through-penetrations, as described in paragraph GENERAL REQUIREMENTS, shall provide "F" and "T" fire resistance ratings in accordance with ASTM E 814 or UL 1479, except that T Ratings are not required for penetrations smaller than or equal to a 100 mm nominal pipe or 0.01 square meter in overall cross sectional area. Fire resistance ratings shall be the following:

- a. Penetrations of Fire Resistance Rated Walls and Partitions: F Rating = one hour, T Rating = one hour.
- b. Penetrations of Fire Resistance Rated Floors and Ceiling-Floor Assemblies; F Rating = one hour, T Rating = one hour.

#### 2.1.3.2 Construction Joints and Gaps

Fire resistance ratings of construction joints, as described in paragraph GENERAL REQUIREMENTS, and gaps such as those between floor slabs or roof decks and curtain walls shall be the same as the construction in which they occur.

## 3 EXECUTION

### 3.1 PREPARATION

Areas to receive firestopping shall be free of dirt, grease, oil, or loose materials which may affect the fitting or fire resistance of the firestopping system.

### 3.2 INSTALLATION

Firestopping material shall completely fill void spaces regardless of geometric configuration, subject to tolerance established by the manufacturer. Firestopping for filling floor voids 100 mm or more in any direction shall be capable of supporting the same load as the floor is designed to support or shall be protected by a permanent barrier to prevent loading or traffic in the firestopped area. Firestopping shall be installed in accordance with manufacturer's written instructions. Firestopping shall be provided in the following locations, except in floor slabs on grade:

- a. Penetrations of duct, conduit, tubing, cable and pipe through floors and through fire-resistance rated walls, partitions, and ceiling-floor assemblies.
- b. Penetrations of vertical shafts such as pipe chases, elevator shafts, and utility chutes.
- c. Gaps at the intersection of floor slabs and curtain walls, including inside of hollow curtain walls at the floor slab.

- d. Gaps at perimeter of fire-resistance rated walls and partitions, such as between the top of the walls and the bottom of roof decks.
- e. Construction joints in floors and fire rated walls and partitions.
- f. Other locations where required to maintain fire resistance rating of the construction.

### 3.3 INSPECTION

Firestopped areas shall not be covered or enclosed until inspection is complete and approved. A manufacturer's representative shall inspect the applications initially to ensure adequate preparations (clean surfaces suitable for application, etc.) and periodically during the work to assure that the completed work has been accomplished according to the manufacturer's written instructions and the specified requirements.

## SECTION 07412

## NON-STRUCTURAL METAL ROOFING

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 463	(1996a) Steel Sheet, Aluminum-Coated, by the Hot-Dip Process
ASTM A 653	(1996) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 792	(1995) Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
ASTM B 117	(1994) Operating Salt Spray (Fog) Testing Apparatus
ASTM B 209	(1996) Aluminum and Aluminum-Alloy Sheet and Plate
ASTM D 226	(1994) Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D 522	(1993a) Mandrel Bend Test of Attached Organic Coatings
ASTM D 523	(1989; R 1994) Specular Gloss
ASTM D 714	(1987; R 1994) Evaluating Degree of Blistering of Paints
ASTM D 968	(1993) Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM D 1308	(1987; R 1993) Effect of Household Chemicals on Clear and Pigmented Organic Finishes
ASTM D 1654	(1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D 2244	(1993) Calculation of Color Differences from Instrumentally Measured Color Coordinates
ASTM D 2247	(1994) Testing Water Resistance of Coatings in 100% Relative Humidity

ASTM D 2794	(1993) Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
ASTM D 3359	(1995) Measuring Adhesion by Tape Test
ASTM D 4214	(1989) Evaluating the Degree of Chalking of Exterior Paint Films
ASTM D 4587	(1991) Conducting Tests on Paint and Related Coatings and Materials Using a Fluorescent UV-Condensation Light- and Water- Exposure Apparatus

## 1.2 GENERAL REQUIREMENTS

The Contractor shall furnish a manufacturer's standard product which satisfies the specified design and additional requirements contained herein. The roofing system shall be provided by the Contractor as a complete system as tested and approved in accordance with UL-580. Roof panels, components, transitions, accessories, and assemblies shall be supplied by the same roofing system manufacturer.

### 1.2.1 NON-STRUCTURAL METAL ROOFING SYSTEM

The Non-Structural Metal Roofing System covered under this specification shall include the entire roofing system; the standing seam metal roof panels, fasteners, connectors, roof securing components, and assemblies tested and approved in accordance with UL 580. In addition, the system shall consist of panel finishes, slip sheet, all accessories, components, and trim and all connections with roof panels. This includes roof penetration items such as Vents, curbs, skylights; interior or exterior gutters and downspouts; eaves, ridge, hip, valley, rake, gable, wall, or other roof system flashings installed and any other components specified within this contract to provide a weathertight roof system; and items specified in other sections of the specifications that are part of the system.

## 1.3 DESIGN LOADS

Wind uplift pressures in accordance with ASCE 7 are shown on the contract drawings. In addition, the roofing system shall be fully approved to meet wind uplift requirements of Class 90 as defined in U.L.-580, latest edition.

## 1.4 PERFORMANCE REQUIREMENTS

The metal roofing system supplied shall be suitable for the roof slope, the underlayment, and uplift pressures shown on the contract drawings.

## 1.5 GENERAL REQUIREMENTS

The Contractor shall furnish a manufacturer's standard product which satisfies the specified design and additional requirements contained herein.

### 1.5.1 Manufacturer

The non-structural metal roofing system shall be the product of a manufacturer who has been in the practice of manufacturing metal roofs for a

period of not less than 3 years and has been involved in at least five projects similar in size and complexity to this project. The non-structural metal roofing system shall be the product of one of the following manufacturers.

1. Butler Manufacturing
2. Berridge Manufacturing Co.
3. Smith Steelite
4. Morin Corporation
5. H.H. Robertson Company
6. Merchant & Evans

The naming of the above manufacturers does not relieve any requirement for the manufacturer's product to comply with all other specification provisions herein.

#### 1.5.2 Manufacturer's Representative

A representative of the manufacturer, who is familiar with the design of the roof system supplied and experienced in the erection of roof systems similar in size to the one required under this contract, shall be present at the job site at all times during installation of the system to assure that the roof system meets the specified requirements. The manufacturer's representative shall be either an employee of the manufacturer with at least two years experience in installing the roof system or an employee of an independent installer that is certified by the manufacturer to have two years of experience installing similar roof systems.

#### 1.5.3 Installer

The installer shall have a minimum of 2 years experience and shall have been involved in installing at least 3 projects that are of comparable size, scope and complexity as this project for the particular roof system furnished. The installer shall be trained and/or certified by the manufacturer to install the particular roof system specified. Training and certification shall be defined to include formal hands-on training given by the manufacturer in the installation of the specified roofing system. The training program shall have been in existence for not less than one year and shall include, but not be limited to the following: a specific course outline describing the goals of the training program and how those goals are met by the training; pertinent quality control methods of installation; and means of correcting work not meeting contract requirements.

The following manufacturers are known to have training/certification programs which comply with the foregoing requirement:

1. Butler Manufacturing Co.
2. Merchant & Evans, Inc.
3. Smith Steelite Inc.

#### 1.6 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:



## SD-04 Drawings

Metal Roofing; GA.

a. Drawings consisting of catalog cuts, erection drawings, shop coating and finishing specifications, and other data as necessary to clearly describe materials, sizes, layouts, construction details, fasteners, and erection.

b. Drawings shall clearly demonstrate proposed system's ability to meet UL assembly requirements.

## SD-08 Statements

Qualifications; GA.

Qualifications of the manufacturer, manufacturer's representative, and installer. Qualifications statement(s) shall clearly provide evidence of the following: a. installer is certified by roofing system manufacturer to install the system, b. proof that the manufacturer's representative is directly compensated by the manufacturer, c. proof of representative's and installer's authorized training by the manufacturer.

## SD-13 Certificates

Roof Panels; FIO. Installation; FIO. Accessories; FIO.

Certificates attesting that the panels and accessories conform to the specified requirements. Certificate for the roof assembly shall certify that the assembly complies with the material and fabrication requirements specified and is suitable for the installation at the indicated design slope. Certified laboratory test reports showing that the sheets to be furnished are produced under a continuing quality control program and that at least five (5) representative samples of similar material to that which will be provided on this project have been previously tested and have met the quality standards specified for factory color finish.

Installer; GA.

Certification of installer.

Warranties; GA.

At the completion of the project, signed copies of the 5-year Warranty for Non-Structural Metal Roofing System, a sample copy of which is attached to this section, and the 20-year Manufacturer's Material Warranties. During the submittal process, evidence of adherence to warranty requirements must be shown.

## SD-14 Samples

Accessories; GA.

One sample of each type of flashing, trim, fascia, closure, cap and similar items. Size shall be sufficient to show construction and configuration.

Roof Panels; GA.

One piece of each type and finish to be used, 225 mm long, full width.

Fasteners; FIO.

Two samples of each type to be used with statement regarding intended use. If so requested, random samples of screws, bolts, nuts, and washers as delivered to the jobsite shall be taken in the presence of the Contracting Officer and provided to the Contracting Officer for testing to establish compliance with specified requirements.

Gaskets and Insulating Compounds; FIO.

Two samples of each type to be used and descriptive data.

Sealant; FIO.

One sample, approximately 0.5 kg, and descriptive data.

#### 1.7 DELIVERY AND STORAGE

Materials shall be delivered to the site in a dry and undamaged condition and stored out of contact with the ground. Materials shall be covered with weather tight coverings and kept dry. Material shall not be covered with plastic where such covering will allow sweating and condensation. Plastic may be used as tenting with air circulation allowed. Storage conditions shall provide good air circulation and protection from surface staining.

#### 1.8 WARRANTIES

The Non-Structural Metal Roofing System shall be warranted as outlined below.

##### 1.8.1 Contractor's Weathertightness Warranty

The Non-Structural Metal Roofing System shall be warranted by the Contractor on a no penal sum basis for a period of five years against material and workmanship deficiencies; system deterioration caused by exposure to the elements and/or inadequate resistance to specified service design loads, water leaks, and wind uplift damage. The SSSMR system covered under this warranty shall include the entire roofing system includes but is not limited to; the standing seam metal roof panels, fasteners, connectors, roof securing components, and assemblies tested and approved in accordance with UL 580. In addition, the system shall consist of panel finishes, slip sheet, insulation, vapor retarder, all accessories, components, and trim and all connections with roof panels. This includes roof penetration items such as Vents, curbs, skylights; interior or exterior gutters and downspouts; eaves, ridge, hip, valley, rake, gable, wall, or other roof system flashings installed and any other components specified within this contract to provide a weathertight roof system; and items specified in other sections of the specifications that are part of the roof system. All material and workmanship deficiencies, system deterioration caused by exposure to the elements and/or inadequate service design loads, water leaks and wind uplift damage shall be repaired as approved by the Contracting Officer. See the attached Contractor's required warranty for issue resolution of warrantable defects. This warranty shall warrant and cover the entire cost of repair or

replacement, including all material, labor, and related markups. The Contractor shall supplement this warranty with written warranties from the installer and system manufacturer, which shall be submitted along with Contractor's warranty; however, the Contractor shall be ultimately responsible for this warranty. The Contractor's written warranty shall be as outlined in attached WARRANTY FOR NON-STRUCTURAL METAL ROOF SYSTEM, and shall start upon final acceptance of the facility. It is required that the contractor provide a separate bond, in favor of the owner (Government), covering the contractor's warranty responsibilities and will remain effective throughout the five year Contractor's warranty period for the entire roofing system as outlined above.

#### 1.8.2 Manufacturer's Material Warranties

The Contractor shall furnish, in writing, the following manufacturer's material warranties which cover all Non-Structural Metal Roofing System components such as roof panels, flashing, accessories, and trim, fabricated from coil material:

- a. A manufacturer's 20 year material warranty warranting that the aluminum, zinc-coated steel, aluminum-zinc alloy coated steel or aluminum-coated steel as specified herein will not rupture, fail structurally, or perforate under normal atmospheric conditions at the site. Liability under this warranty shall be limited exclusively to the cost of either repairing or replacing nonconforming, ruptured, perforated, or structurally failed coil material.
- b. A manufacturer's 20 year exterior material finish warranty warranting that the factory color finish, under normal atmospheric conditions at the site, will not crack, peel, or delaminate; chalk in excess of a numerical rating of 8 when measured in accordance with ASTM D 4214; or fade or change colors in excess of 5 NBS units as measured in accordance with ASTM D 2244. Liability under this warranty is exclusively limited to refinishing or replacing the defective coated coil material.

## 2 PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

Acceptable systems and manufacturers are the following:

'VSR'; Butler Manufacturing Company (primarily a structural type system, but may be used for all roof slopes within project)

'305 Series', Zip-Rib; Merchant & Evans Inc. (for all roof slopes except @ roof cricket of community building)

'PS-1, "original Zip-Rib"; Merchant & Evans Inc. (primarily a structural type system, but can be used as non-structural system and can be used for all roof slopes within project)

'Interlock 18, Zip-Rib'; Merchant & Evans Inc. (structural type system, but may be used for all roof slopes except @ roof cricket of community building)

'SRS'; Smith-Steelite Inc. (primarily a structural type system, but may be used for all roof slopes within project)

Other approved systems by other manufacturers which meet the requirements herein.

## 2.2 ROOF PANELS

Panels shall be steel or aluminum and shall have a factory color finish. Length of sheets shall be sufficient to cover the entire length of any unbroken roof slope for slope lengths that do not exceed 9 m. Sheets longer than 9 m may be furnished if approved by the Contracting Officer. Width of sheets shall provide nominal 300 mm of coverage in place. Design provisions shall be made for thermal expansion and contraction consistent with the type of system to be used. All sheets shall be either square-cut or miter-cut. The ridge cap shall not have exposed fasteners. Height of corrugations, ribs, or seams, at overlap of adjacent roof sheets shall be the building manufacturer's standard for the indicated roof slope.

### 2.2.1 Steel Panels

Zinc-coated steel conforming to ASTM A 653; aluminum-zinc alloy coated steel conforming to ASTM A 792, AZ 55 coating; or aluminum-coated steel conforming to ASTM A 463, Type 2, coating designation T2 65. Uncoated roof panels shall be 0.6 mm thick minimum. Panels shall be within 95 percent of the nominal thickness. Prior to shipment, mill finish panels shall be treated with a passivating chemical and oiled to inhibit the formation of oxide corrosion products. Panels that have become wet during shipment and have started to oxidize shall be rejected.

### 2.2.2 Aluminum Panels

Alloy conforming to ASTM B 209, temper as required for the forming operation, minimum 0.8 mm thick.

## 2.3 ACCESSORIES

Accessories shall be compatible with the roofing furnished. Flashing, trim, metal closure strips, caps, and similar metal accessories shall be not less than the minimum thicknesses specified for roof panels. Exposed metal accessories shall be finished to match the panels furnished. Molded closure strips shall be bituminous-saturated fiber, closed-cell or solid-cell synthetic rubber or neoprene, or polyvinyl chloride premolded to match configuration of the panels and shall not absorb or retain water.

## 2.4 FASTENERS

Fasteners for roof panels shall be zinc-coated steel, aluminum, or nylon capped steel, type and size as recommended by the manufacturer to meet the performance requirements. Fasteners for accessories shall be the manufacturer's standard. Exposed roof fasteners shall be gasketed or have gasketed washers on the exterior side of the roofing to waterproof the fastener penetration. Washer material shall be compatible with the panels; and gasketed portion of fasteners or washers shall be neoprene or other equally durable elastomeric material approximately 3 mm thick.

## 2.5 FACTORY COLOR FINISH

Panels shall have a factory applied polyvinylidene fluoride finish on the exposed side. The exterior finish shall consist of a baked-on topcoat with an appropriate prime coat. Color shall match the color indicated in Section 09915 COLOR SCHEDULE. The exterior coating shall be a nominal 0.025 mm thickness consisting of a topcoat of not less than 0.018 mm dry film thickness and the paint manufacturer's recommended primer of not less than 0.008 mm thickness. The exterior color finish shall meet the test requirements specified below.

### 2.5.1 Salt Spray Test

A sample of the sheets shall withstand a salt spray test for a minimum of 1000 hours in accordance with ASTM B 117, including the scribe requirement in the test. Immediately upon removal of the panel from the test, the coating shall receive a rating of not less than 8F, few no. 8 blisters, as determined by ASTM D 714; and a rating of 6, 3 mm failure at scribe, as determined by ASTM D 1654.

### 2.5.2 Formability Test

When subjected to testing in accordance with ASTM D 522 Method B, 3 mm diameter mandrel, the coating film shall show no evidence of fracturing to the naked eye.

### 2.5.3 Accelerated Weathering, Chalking Resistance and Color Change

A sample of the sheets shall be tested in accordance with ASTM D 4587, test condition D for 1000 total hours. The coating shall withstand the weathering test without cracking, peeling, blistering, loss of adhesion of the protective coating, or corrosion of the base metal. Protective coating that can be readily removed from the base metal with tape in accordance with ASTM D 3359, Test Method B, shall be considered as an area indicating loss of adhesion. Following the accelerated weathering test, the coating shall have a chalk rating not less than No. 8 in accordance with ASTM D 4214 test procedures, and the color change shall not exceed 5 CIE or Hunter Lab color difference (delta E) units in accordance with ASTM D 2244.

### 2.5.4 Humidity Test

When subjected to a humidity cabinet test in accordance with ASTM D 2247 for 1000 hours, a scored panel shall show no signs of blistering, cracking, creepage or corrosion.

### 2.5.5 Impact Resistance

Factory-painted sheet shall withstand direct and reverse impact in accordance with ASTM D 2794 13 mm diameter hemispherical head indenter, equal to 6.7 times the metal thickness in mm, expressed in N-meters, with no loss of adhesion.

### 2.5.6 Abrasion Resistance Test

When subjected to the falling sand test in accordance with ASTM D 968, Method A, the coating system shall withstand a minimum of 80 liters of sand

before the appearance of the base metal. The term "appearance of base metal" refers to the metallic coating on steel or the aluminum base metal.

#### 2.5.7 Specular Gloss

Finished roof surfaces shall have a specular gloss value of 30 plus or minus 5 at 33.33 degrees C when measured in accordance with ASTM D 523.

#### 2.5.8 Pollution Resistance

Coating shall show no visual effects when covered spot tested in a 10 percent hydrochloric acid solution for 24 hours in accordance with ASTM D 1308.

### 2.6 UNDERLAYMENTS

#### 2.6.1 General Requirements

Rubberized underlayment shall be used for all roof slopes under 25% and at all valley, dormer or counterflashed conditions. Felt underlayment shall be used for roof slopes 25% or greater and all other areas not requiring rubberized underlayment.

#### 2.6.2 Felt Underlayment

Felt underlayment shall be No. 30 felt in accordance with ASTM D 226, Type II.

#### 2.6.3 Rubberized Underlayment

Rubberized underlayment shall be equal to "Ice and Water Shield" as manufactured by Grace Construction Products, "Winterguard" as manufactured by CertainTeed Corporation, or "Weather Watch Ice and Water Barrier" as manufactured by GAF Building Materials Corporation.

#### 2.6.4 Slip Sheet

Slip Sheet shall be 0.24 kg per square meter rosin sized unsaturated building paper.

### 2.7 INSULATION

Insulation is referenced in Section 03512, COMPOSITE STRUCTURAL CEMENTITIOUS WOOD FIBER ROOF DECK.

### 2.8 SEALANT

Sealant shall be an elastomeric type containing no oil or asphalt. Exposed sealant shall be colored to match the applicable building color and shall cure to a rubberlike consistency, however sealant within the roofing system should not be intentionally exposed.

### 2.9 GASKETS AND INSULATING COMPOUNDS

Gaskets and insulating compounds shall be nonabsorptive and suitable for insulating contact points of incompatible materials. Insulating compounds shall be nonrunning after drying.

## 2.10 VAPOR RETARDER

Vapor retarder requirements are specified in section 03512 - COMPOSITE NON-STRUCTURAL CEMENTITIOUS WOOD FIBER ROOF DECK.

## 3 EXECUTION

### 3.1 INSTALLATION

Installation shall be in accordance with the manufacturer's erection instructions and drawings. Dissimilar materials which are not compatible when contacting each other shall be insulated by means of gaskets or insulating compounds. Improper or mislocated drill holes shall be plugged with an oversize screw fastener and gasketed washer; however, sheets with an excess of such holes or with such holes in critical locations shall not be used. Exposed surfaces and edges shall be kept clean and free from sealant, metal cuttings, hazardous burrs, and other foreign material. Stained, discolored, or damaged sheets shall be removed from the site.

#### 3.1.1 Roofing

Side laps shall be laid away from the prevailing winds. Side and end lap distances, joint sealing, and fastening and spacing of fasteners shall be in accordance with manufacturer's standard practice. Spacing of exposed fasteners shall present an orderly appearance. Side laps and end laps of roof panels and joints at accessories shall be sealed. Fasteners shall be driven normal to the surface. Method of applying joint sealant shall conform to the manufacturer's recommendation to achieve a complete weathertight installation. Accessories shall be fastened into substrate, except as otherwise approved. Closure strips shall be provided as indicated and where necessary to provide weathertight construction.

#### 3.1.2 Field forming of Roof Panels

When roofing panels are formed from factory-color-finished steel coils at the project site, the same care and quality control measures that are taken in shop forming of roofing panels shall be observed. Rollformer shall be operated by the metal roofing manufacturer's representative. In cold weather conditions, preheating of the steel coils to be field formed shall be performed as necessary just prior to the rolling operations.

#### 3.1.3 Underlayment

Underlayment types shall be installed where shown on the drawings; they shall be installed directly over the substrate. If a roof panel rests directly on the underlayments, a slip sheet shall be installed as a top layer, beneath the metal roofing panels, to prevent adhesion. All underlayments shall be installed so that successive strips overlap the next lower strip in shingle fashion. Underlayments shall be installed in accordance with the manufacturer's written instructions. The underlayments shall ensure that any water that penetrates below the metal roofing panels will drain outside of the building envelope.

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY  
FOR  
NON - STRUCTURAL METAL ROOF SYSTEM

FACILITY  
DESCRIPTION: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

BUILDING  
NUMBER: \_\_\_\_\_  
\_\_\_\_\_

CORPS OF ENGINEERS CONTRACT  
NUMBER: \_\_\_\_\_  
\_\_\_\_\_

CONTRACTOR  
CONTRACTOR: \_\_\_\_\_  
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ADDRESS: \_\_\_\_\_  
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CONSTRUCTION AGENT

CONSTRUCTION

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CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY  
FOR  
NON - STRUCTURAL METAL ROOF SYSTEM  
(continued)

THE NON-STRUCTURAL METAL ROOF SYSTEM INSTALLED ON THE ABOVE NAMED BUILDING IS WARRANTED BY \_\_\_\_\_ FOR A PERIOD OF FIVE (5) YEARS AGAINST WORKMANSHIP AND MATERIAL DEFICIENCIES, WIND DAMAGE, STRUCTURAL FAILURE AND LEAKAGE. THE STANDING SEAM METAL ROOFING SYSTEM COVERED UNDER THIS WARRANTY SHALL INCLUDE BUT NOT BE LIMITED TO THE FOLLOWING: THE ENTIRE ROOFING SYSTEM MANUFACTURER SUPPLIED FRAMING AND STRUCTURAL MEMBERS, METAL ROOF PANELS, FASTENERS, CONNECTORS, ROOF SECUREMENT COMPONENTS, AND ASSEMBLIES TESTED AND APPROVED IN ACCORDANCE WITH ASTM E 1592. IN ADDITION, THE SYSTEM PANEL FINISHES, SLIP SHEET, INSULATION, VAPOR RETARDER, ALL ACCESSORIES, COMPONENTS, AND TRIM AND ALL CONNECTIONS ARE INCLUDED. THIS INCLUDES ROOF PENETRATION ITEMS SUCH AS VENTS, CURBS, SKYLIGHTS; INTERIOR OR EXTERIOR GUTTERS AND DOWNSPOUTS; EAVES, RIDGE, HIP, VALLEY, RAKE, GABLE, WALL, OR OTHER ROOF SYSTEM FLASHINGS INSTALLED AND ANY OTHER COMPONENTS SPECIFIED WITHIN THIS CONTRACT TO PROVIDE A WEATHERTIGHT ROOF SYSTEM; AND ITEMS SPECIFIED IN OTHER SECTIONS OF THE SPECIFICATIONS THAT ARE PART OF THE ROOF SYSTEM.

ALL MATERIAL DEFICIENCIES, WIND DAMAGE, STRUCTURAL FAILURE AND LEAKAGE ASSOCIATED WITH THE NON-STRUCTURAL METAL ROOF SYSTEM COVERED UNDER THIS WARRANTY SHALL BE REPAIRED AS APPROVED BY THE CONTRACTING OFFICER. THIS WARRANTY SHALL COVER THE ENTIRE COST OF REPAIR OR REPLACEMENT, INCLUDING ALL MATERIAL, LABOR, AND RELATED MARKUPS. THE ABOVE REFERENCED WARRANTY COMMENCED ON THE DATE OF FINAL ACCEPTANCE ON \_\_\_\_\_ AND WILL REMAIN IN EFFECT FOR STATED DURATION FROM THIS DATE.

SIGNED, DATED, AND NOTARIZED (BY COMPANY PRESIDENT)

\_\_\_\_\_  
(Company President)

\_\_\_\_\_  
(Date)

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY  
FOR  
NON - STRUCTURAL METAL ROOF SYSTEM  
(continued)

THE CONTRACTOR SHALL SUPPLEMENT THIS WARRANTY WITH WRITTEN WARRANTIES FROM THE MANUFACTURER AND/OR INSTALLER OF THE NON-STRUCTURAL METAL ROOF SYSTEM, WHICH SHALL BE SUBMITTED ALONG WITH THE CONTRACTOR'S WARRANTY. HOWEVER, THE CONTRACTOR WILL BE ULTIMATELY RESPONSIBLE FOR THE THIS WARRANTY AS OUTLINED IN THE SPECIFICATIONS AND AS INDICATED IN THIS WARRANTY. EXAMPLE.

EXCLUSIONS FROM COVERAGE

1. NATURAL DISASTERS, ACTS OF GOD (LIGHTNING, FIRE, EXPLOSIONS, SUSTAINED WIND FORCES IN EXCESS OF THE DESIGN CRITERIA, EARTHQUAKES, AND HAIL).
2. ACTS OF NEGLIGENCE OR ABUSE OR MISUSE BY GOVERNMENT OR OTHER PERSONNEL, INCLUDING ACCIDENTS, VANDALISM, CIVIL DISOBEDIENCE, WAR, OR DAMAGE CAUSED BY FALLING OBJECTS.
3. DAMAGE BY STRUCTURAL FAILURE, SETTLEMENT, MOVEMENT, DISTORTION, WARPAGE, OR DISPLACEMENT OF THE BUILDING STRUCTURE OR ALTERATIONS MADE TO THE BUILDING.
4. CORROSION CAUSED BY EXPOSURE TO CORROSIVE CHEMICALS, ASH OR FUMES GENERATED OR RELEASED INSIDE OR OUTSIDE THE BUILDING FROM CHEMICAL PLANTS, FOUNDRIES, PLATING WORKS, KILNS, FERTILIZER FACTORIES, PAPER PLANTS, AND THE LIKE.
5. FAILURE OF ANY PART OF THE NON-STRUCTURAL METAL ROOF DUE TO ACTIONS BY THE OWNER TO INHIBIT FREE DRAINAGE OF WATER FROM THE ROOF AND GUTTERS AND DOWNSPOUTS OR ALLOW PONDING WATER TO COLLECT ON THE ROOF SURFACE. CONTRACTOR'S DESIGN SHALL INSURE FREE DRAINAGE FROM THE ROOF AND NOT ALLOW PONDING WATER.
6. THIS WARRANTY APPLIES TO THE NON-STRUCTURAL METAL ROOF SYSTEM. IT DOES NOT INCLUDE ANY CONSEQUENTIAL DAMAGE TO THE BUILDING INTERIOR OR CONTENTS WHICH IS COVERED BY THE WARRANTY OF CONSTRUCTION CLAUSE INCLUDED IN THIS CONTRACT.
7. THIS WARRANTY CANNOT BE TRANSFERRED TO ANOTHER OWNER WITHOUT WRITTEN CONSENT OF THE CONTRACTOR AND THIS WARRANTY AND THE CONTRACT PROVISIONS WILL TAKE PRECEDENCE OVER ANY CONFLICTS WITH STATE STATUTES.

REPORTS OF LEAKS AND ROOF SYSTEM DEFICIENCIES SHALL BE RESPONDED TO WITHIN 48 HOURS OF RECEIPT OF NOTICE BY TELEPHONE OR IN WRITING FROM EITHER THE OWNER, OR CONTRACTING OFFICER. EMERGENCY REPAIRS, TO PREVENT FURTHER ROOF LEAKS, SHALL BE INITIATED IMMEDIATELY; A WRITTEN PLAN SHALL BE SUBMITTED FOR APPROVAL TO REPAIR OR REPLACE THIS ROOF SYSTEM WITHIN SEVEN CALENDAR DAYS. ACTUAL WORK FOR PERMANENT REPAIRS OR REPLACEMENT SHALL BE STARTED WITHIN 30 DAYS AFTER RECEIPT OF NOTICE, AND COMPLETED WITHIN A REASONABLE TIME FRAME. IF THE CONTRACTOR FAILS TO ADEQUATELY RESPOND TO THE WARRANTY PROVISIONS, AS STATED IN THE CONTRACT

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY  
FOR  
NON - STRUCTURAL METAL ROOF SYSTEM  
(Continued)

AND AS CONTAINED HEREIN, THE CONTRACTING OFFICER MAY HAVE THE NON-STRUCTURAL METAL ROOF SYSTEM REPAIRED OR REPAIRED BY OTHERS AND CHARGE THE COST TO THE CONTRACTOR. IN THE EVENT THE CONTRACTOR DISPUTES THE EXISTENCE OF A WARRANTABLE DEFECT HE MAY CHALLENGE THE OWNER'S DEMAND FOR REPAIRS AND/OR REPLACEMENT DIRECTED BY THE OWNER OR CONTRACTING OFFICER EITHER BY REQUESTING A CONTRACTING OFFICER'S DECISION, UNDER THE CONTRACT DISPUTES ACT, OR BY REQUESTING THAT AN ARBITRATOR RESOLVE THE ISSUE. THE REQUEST FOR AN ARBITRATOR MUST BE MADE WITHIN 48 HOURS OF BEING NOTIFIED OF THE DISPUTED DEFECTS. UPON BEING INVOKED THE PARTIES SHALL, WITHIN 10 DAYS JOINTLY REQUEST A LIST OF FIVE (5) ARBITRATORS FROM THE FEDERAL MEDIATION AND CONCILIATION SERVICE. THE PARTIES SHALL CONFER WITHIN 10 DAYS AFTER RECEIPT OF THE LIST TO SEEK AGREEMENT ON AN ARBITRATOR. IF THE PARTIES CANNOT AGREE ON AN ARBITRATOR, THE CONTRACTING OFFICER AND THE PRESIDENT OF THE CONTRACTOR'S COMPANY WILL STRIKE ONE (1) NAME FROM THE LIST ALTERNATIVELY UNTIL ONE NAME REMAINS. THE REMAINING PERSON SHALL BE THE DULY SELECTED ARBITRATOR. THE COSTS OF THE ARBITRATION, INCLUDING THE ARBITRATOR'S FEE AND EXPENSES, COURT REPORTER, COURTROOM OR SITE SELECTED ETC., SHALL BE BORNE EQUALLY BETWEEN THE PARTIES. EITHER PARTY DESIRING A COPY OF THE TRANSCRIPT SHALL PAY FOR THE TRANSCRIPT. A HEARING WILL BE HELD AS SOON AS THE PARTIES CAN MUTUALLY AGREE. A WRITTEN ARBITRATOR'S DECISION WILL BE REQUESTED NOT LATER THAN 30 DAYS FOLLOWING THE HEARING. THE DECISION OF THE ARBITRATOR WILL NOT BE BINDING; HOWEVER, IT WILL BE ADMISSIBLE IN ANY SUBSEQUENT APPEAL UNDER THE CONTRACT DISPUTES ACT.

A FRAMED COPY OF THIS WARRANTY SHALL BE POSTED IN THE MECHANICAL ROOM OR OTHER APPROVED LOCATION DURING THE ENTIRE WARRANTY PERIOD.

END

## SECTION 07413

## METAL SIDING

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## ALUMINUM ASSOCIATION (AA)

AA-02 (1994) Aluminum Design Manual: Specifications and Guidelines for Aluminum Structures

## AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI-01 (1986; Addenda 1989) Cold-Formed Steel Design Manual

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 463 (1996a) Steel Sheet, Aluminum-Coated, by the Hot-Dip Process

ASTM A 653 (1996) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

ASTM A 792 (1995) Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process

ASTM B 117 (1994) Operating Salt Spray (Fog) Testing Apparatus

ASTM B 209 (1996) Aluminum and Aluminum-Alloy Sheet and Plate

ASTM C 518 (1991) Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus

ASTM D 522 (1993a) Mandrel Bend Test of Attached Organic Coatings

ASTM D 714 (1987; R 1994) Evaluating Degree of Blistering of Paints

ASTM D 968 (1993) Abrasion Resistance of Organic Coatings by Falling Abrasive

ASTM D 1654 (1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments

ASTM D 2244	(1993) Calculation of Color Differences from Instrumentally Measured Color Coordinates
ASTM D 2247	(1994) Testing Water Resistance of Coatings in 100% Relative Humidity
ASTM D 2794	(1993) Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
ASTM D 3359	(1995) Measuring Adhesion by Tape Test
ASTM D 4214	(1989) Evaluating the Degree of Chalking of Exterior Paint Films
ASTM D 4587	(1991) Conducting Tests on Paint and Related Coatings and Materials Using a Fluorescent UV-Condensation Light- and Water- Exposure Apparatus
ASTM E 84	(1995a) Surface Burning Characteristics of Building Materials
ASTM E 96	(1995) Water Vapor Transmission of Materials

#### AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7	(1995) Minimum Design Loads for Buildings and Other Structures
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## 1.2 GENERAL REQUIREMENTS

### 1.2.1 Design

Criteria, loading combinations, and definitions shall be in accordance with ASCE 7. Maximum calculated fiber stress shall not exceed the allowable value in the AISI or AA manuals; a one third overstress for wind is allowed. Midspan deflection under maximum design loads shall be limited to  $L/180$ . Contract drawings show the design wind loads and the extent and general assembly details of the metal siding. Members and connections not shown on the drawings shall be designed by the Contractor. Siding panels and accessories shall be the products of the same manufacturer. Steel siding design shall be in accordance with AISI-01. Aluminum siding design shall be in accordance with AA-02.

### 1.2.2 Architectural Considerations

Panels profile shall be as shown on the drawings.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

## SD-04 Drawings

Siding; GA.

Drawings consisting of catalog cuts, design and erection drawings, shop coating and finishing specifications, and other data as necessary to clearly describe design, materials, sizes, layouts, construction details, fasteners, and erection. Drawings shall be accompanied by engineering design calculations for the siding panels.

## SD-13 Certificates

Siding; FIO. Installation; FIO. Accessories; FIO.

Certificates attesting that the panels and accessories conform to the requirements specified. Certified laboratory test reports showing that the sheets to be furnished are produced under a continuing quality control program and that a representative sample consisting of not less than 5 pieces has been tested and has met the quality standards specified for factory color finish. Mill certification for structural bolts, siding, and wall liner panels.

Insulation; FIO.

Certificate attesting that the insulation furnished for the project contains recovered material, and showing an estimated percent of such recovered material.

## SD-14 Samples

Accessories; FIO.

One sample of each type of flashing, trim, closure, cap and similar items. Size shall be sufficient to show construction and configuration.

Siding; FIO.

One piece of each type and finish (exterior and interior) to be used, 225 mm long, full width.

Fasteners; FIO.

Two samples of each type to be used with statement regarding intended use. If so requested, random samples of bolts, nuts, and washers as delivered to the jobsite shall be taken in the presence of the Contracting Officer and provided to the Contracting Officer for testing to establish compliance with specified requirements.

Insulation; FIO.

One piece of each type to be used, and descriptive data covering installation.

Gaskets and Insulating Compounds; FIO.

Two samples of each type to be used and descriptive data.



Sealant; FIO.

One sample, approximately 0.5 kg, and descriptive data.

Wall Liners; FIO.

One piece, 225 mm long, full width.

#### 1.4 DELIVERY AND STORAGE

Materials shall be delivered to the site in a dry and undamaged condition and stored out of contact with the ground. Materials shall be covered with weathertight coverings and kept dry. Storage accommodations for metal siding shall provide good air circulation and protection from surface staining.

#### 1.5 WARRANTIES

The Contractor shall provide a weather tight warranty for the metal siding for a period of 20 years to include siding panel assembly, 10 years against the wear of color finish, and 10 years against the corrosion of fasteners caused by ordinary wear and tear by the elements. The warranties shall start upon final acceptance of the work or the date the Government takes possession, whichever is earlier.

### 2 PRODUCTS

#### 2.1 SIDING

Panels shall be steel or aluminum and shall have a factory color finish. Length of sheets shall be sufficient to cover the entire height of any unbroken wall surface when length of run is 9 m or less. When length of run exceeds 9 m, each sheet in the run shall extend over two or more spans. Sheets longer than 9 m may be furnished if approved by the Contracting Officer. Width of sheets with overlapping configurations shall provide not less than 600 mm of coverage in place, and those with interlocking ribs shall provide not less than 300 mm of coverage in place.

##### 2.1.1 Wall Panels

Wall panels shall have edge configurations for overlapping adjacent sheets or interlocking ribs for securing adjacent sheets. Wall panels shall be fastened to framework using concealed fasteners.

##### 2.1.2 Steel Panels

Zinc-coated steel conforming to ASTM A 653; aluminum-zinc alloy coated steel conforming to ASTM A 792, AZ 55 coating; or aluminum-coated steel conforming to ASTM A 463, Type 2, coating designation T2 65.

##### 2.1.3 Aluminum Panels

Alloy conforming to ASTM B 209, temper as required for the forming operation, minimum 0.8 mm thick.

#### 2.1.4 Factory Insulated Panels

Insulated wall panels shall be factory-fabricated units with insulating core between metal face sheets, securely fastened together and uniformly separated with rigid spacers; facing of steel or aluminum of composition and gauge specified for siding; and constructed to eliminate condensation on interior of the panel. Panels shall have a factory color finish. Insulation shall be compatible with adjoining materials; nonrunning and nonsettling; capable of retaining its R-value for the life of the metal facing sheets; and unaffected by extremes of temperature and humidity. The assembly shall have a flame spread rating not higher than 25, and smoke developed rating not higher than 100 when tested in accordance with ASTM E 84. The insulation shall remain odorless, free from mold, and not become a source of food and shelter for insects. Panels shall be not less than 200 mm wide and shall be in one piece for unbroken wall heights.

#### 2.2 FACTORY COLOR FINISH

Panels shall have a factory applied polyvinylidene fluoride finish on the exposed side. The exterior finish shall consist of a baked-on topcoat with an appropriate prime coat. Color shall match the color indicated in Section 09915 COLOR SCHEDULE. The exterior coating shall be a nominal 0.025 mm thickness consisting of a topcoat of not less than 0.018 mm dry film thickness and the paint manufacturer's recommended primer of not less than 0.005 mm thickness. The interior color finish shall consist of a 0.005 mm thick prime coat. The exterior color finish shall meet the test requirements specified below.

##### 2.2.1 Salt Spray Test

A sample of the sheets shall withstand a salt spray test for a minimum of 1000 hours in accordance with ASTM B 117, including the scribe requirement in the test. Immediately upon removal of the panel from the test, the coating shall receive a rating of not less than 8F, few no. 8 blisters, as determined by ASTM D 714; and a rating of 6, 3 mm failure at scribe, as determined by ASTM D 1654.

##### 2.2.2 Formability Test

When subjected to testing in accordance with ASTM D 522 Method B, 3 mm diameter mandrel, the coating film shall show no evidence of fracturing to the naked eye.

##### 2.2.3 Accelerated Weathering, Chalking Resistance and Color Change

A sample of the sheets shall be tested in accordance with ASTM D 4587, test condition D for 1000 total hours. The coating shall withstand the weathering test without cracking, peeling, blistering, loss of adhesion of the protective coating, or corrosion of the base metal. Protective coating that can be readily removed from the base metal with tape in accordance with ASTM D 3359, Test Method B, shall be considered as an area indicating loss of adhesion. Following the accelerated weathering test, the coating shall have a chalk rating not less than No. 8 in accordance with ASTM D 4214 test procedures, and the color change shall not exceed 5 CIE or Hunter Lab color difference (delta E) units in accordance with ASTM D 2244. For sheets required to have a low gloss finish, the chalk rating shall be not less than No. 6 and the color difference shall be not greater than 7 units.

#### 2.2.4 Humidity Test

When subjected to a humidity cabinet test in accordance with ASTM D 2247 for 1000 hours, a scored panel shall show no signs of blistering, cracking, creepage or corrosion.

#### 2.2.5 Impact Resistance

Factory-painted sheet shall withstand direct and reverse impact in accordance with ASTM D 2794 13 mm diameter hemispherical head indenter, equal to 6.7 times the metal thickness in mm, expressed in Newton-meters, with no loss of adhesion.

#### 2.2.6 Abrasion Resistance Test

When subjected to the falling sand test in accordance with ASTM D 968, Method A, the coating system shall withstand a minimum of 80 liters of sand before the appearance of the base metal. The term "appearance of base metal" refers to the metallic coating on steel or the aluminum base metal.

### 2.3 ACCESSORIES

Flashing, trim, metal closure strips, caps, and similar metal accessories shall be the manufacturer's standard products. Exposed metal accessories shall be finished to match the panels furnished. Molded closure strips shall be bituminous-saturated fiber, closed-cell or solid-cell synthetic rubber or neoprene, or polyvinyl chlorided premolded to match configuration of the panels and shall not absorb or retain water.

### 2.4 FASTENERS

Fasteners for steel panels shall be zinc-coated steel, aluminum, corrosion resisting steel, or nylon capped steel, type and size specified below or as otherwise approved for the applicable requirements. Fasteners for aluminum panels shall be aluminum or corrosion resisting steel. Fasteners for attaching wall panels to supports shall provide both tensile and shear strength of not less than 3340 N per fastener. Fasteners for accessories shall be the manufacturer's standard. Exposed wall fasteners shall be color finished or provided with plastic color caps to match the panels. Nonpenetrating fastener system for wall panels using concealed clips shall be manufacturer's standard for the system provided.

#### 2.4.1 Screws

Screws shall be as recommended by the manufacturer.

#### 2.4.2 End-Welded Studs

Automatic end-welded studs shall be shouldered type with a shank diameter of not less than 5 mm and cap or nut for holding panels against the shoulder.

#### 2.4.3 Explosive Actuated Fasteners

Fasteners for use with explosive actuated tools shall have a shank of not less than 3.68 mm with a shank length of not less than 13 mm for fastening panels to steel and not less than 25 mm for fastening panels to concrete.

#### 2.4.4 Blind Rivets

Blind rivets shall be aluminum with 5 mm nominal diameter shank or stainless steel with 3 mm nominal diameter shank. Rivets shall be threaded stem type if used for other than the fastening of trim. Rivets with hollow stems shall have closed ends.

#### 2.4.5 Bolts

Bolts shall be not less than 6 mm diameter, shouldered or plain shank as required, with proper nuts.

### 2.5 INSULATION

Thermal resistance of insulation shall be not less than the R-values shown on the contract drawings. R-values shall be determined at a mean temperature of 24 degrees C in accordance with ASTM C 518. Insulation shall be a standard product with the insulation manufacturer, factory-marked or identified with insulation manufacturer's name or trademark and R-value. Identification shall be on individual pieces or individual packages. Insulation, including facings, shall have a flame spread not in excess of 25 and a smoke developed rating not in excess of 200 when tested in accordance with ASTM E 84. The stated R-value of the insulation shall be certified by an independent Registered Professional Engineer if tests are conducted in the insulation manufacturer's laboratory.

### 2.6 VAPOR RETARDER

#### 2.6.1 Vapor Retarders as Integral Facing

Insulation facing shall have a permeability of 5.7 ng per Pa-second-square meter or less when tested in accordance with ASTM E 96. Facing shall be reinforced foil with a vinyl finish; except that unreinforced foil with a natural finish may be used in concealed locations. Facings and finishes shall be factory applied.

### 2.7 SEALANT

Sealant shall be an elastomeric type containing no oil or asphalt. Exposed sealant shall be colored to match the applicable building color and shall cure to a rubberlike consistency.

### 2.8 GASKETS AND INSULATING COMPOUNDS

Gaskets and insulating compounds shall be nonabsorptive and suitable for insulating contact points of incompatible materials. Insulating compounds shall be nonrunning after drying.

## 3 EXECUTION

### 3.1 INSTALLATION

Installation shall be in accordance with the manufacturer's erection instructions and drawings. Dissimilar materials which are not compatible when contacting each other shall be insulated from each other by means of gaskets or insulating compounds. Improper or mislocated drill holes shall

be plugged with an oversize screw fastener and gasketed washer; however, panels with an excess of such holes or with such holes in critical locations shall not be used. Exposed surfaces and edges shall be kept clean and free from sealant, metal cuttings, hazardous burrs, and other foreign material. Stained, discolored, or damaged sheets shall be removed from the site.

### 3.1.1 Siding and Accessories

Siding shall be applied with the longitudinal configurations in the vertical position. Accessories shall be fastened into framing members, except as otherwise approved. Closure strips shall be provided as indicated and where necessary to provide weathertight construction.

#### 3.1.1.1 Lap Type Panels with Exposed Fasteners

End laps shall be made over framing members with fasteners into framing members approximately 50 mm from the end of the overlapping sheet. Side laps shall be laid away from the prevailing winds. Spacing of fasteners shall present an orderly appearance and shall not exceed: 200 mm on center at end laps of siding, 200 mm on center at connection of siding to intermediate supports, and 450 mm on center at side laps of siding except when otherwise approved. Side and end laps of siding and joints at accessories shall be sealed. Fasteners shall be installed in straight lines within a tolerance of 13 mm in the length of a bay. Fasteners shall be driven normal to the surface and to a uniform depth to seat the gasketed washers properly.

#### 3.1.1.2 Concealed Fastener Wall Panels

Panels shall be fastened to framing members with concealed fastening clips or other concealed devices standard with the manufacturer. Spacing of fastening clips and fasteners shall be in accordance with the manufacturer's written instructions. Spacing of fasteners and anchor clips along the panel interlocking ribs shall not exceed 300 mm on center except when otherwise approved. Fasteners shall not puncture metal sheets except as approved for flashing, closures, and trim; exposed fasteners shall be installed in straight lines. Interlocking ribs shall be sealed with factory-applied sealant. Joints at accessories shall be sealed.



US Army Corps  
of Engineers  
Tulsa District

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Fort Sill, Oklahoma

# **Whole Barracks Complex Renewal**

## **Project Specifications Volume IV of V**

October 1998

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## SECTION 07600

## SHEET METALWORK, GENERAL

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 167	(1996) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM B 32	(1995b) Solder Metal
ASTM B 209	(1995) Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B 221	(1996) Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes
ASTM B 370	(1992) Copper Sheet and Strip for Building Construction
ASTM D 226	(1994) Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D 543	(1987) Resistance of Plastics to Chemical Reagents
ASTM D 822	(1995) Conducting Tests on Paint and Related Coatings and Materials Using Filtered Open-Flame Carbon-Arc Light and Water Exposure Apparatus
ASTM D 828	(1993) Tensile Breaking Strength of Paper and Paperboard
ASTM D 1784	(1992) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 2822	(1991) Asphalt Roof Cement
ASTM D 4022	(1994) Coal Tar Roof Cement, Asbestos Containing
ASTM D 4586	(1993) Asphalt Roof Cement, Asbestos Free
ASTM E 96	(1995) Water Vapor Transmission of Materials

## INSECT SCREENING WEAVERS ASSOCIATION (ISWA)

ISWA IWS 089 (1990) Recommended Standards and  
Specifications for Insect Wire Screening  
(Wire Fabric)

SHEET METAL AND AIR CONDITIONING CONTRACTORS NATIONAL ASSOCIATION  
(SMACNA)

SMACNA-02 (1993) Architectural Sheet Metal Manual

## 1.2 GENERAL REQUIREMENTS

Sheet metalwork shall be accomplished to form weathertight construction without waves, warps, buckles, fastening stresses or distortion, and shall allow for expansion and contraction.

## 1.2.1 Coordination

Cutting, fitting, drilling, and other operations in connection with sheet metal required to accommodate the work of other trades shall be performed by sheet metal mechanics. Installation of sheet metal items used in conjunction with roofing shall be coordinated with roofing work to permit continuous roofing operations. Sheet metalwork pertaining to heating, ventilating, and air conditioning is specified in Section 15895.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

## SD-04 Drawings

Materials; FIO.

Drawings of sheet metal items showing weights, gauges or thicknesses; types of materials; expansion-joint spacing; fabrication details; and installation procedures.

## 1.4 DELIVERY, STORAGE, AND HANDLING

Materials shall be adequately packaged and protected during shipment and shall be inspected for damage, dampness, and wet-storage stains upon delivery to the jobsite. Materials shall be clearly labeled as to type and manufacturer. Sheet metal items shall be carefully handled to avoid damage. Materials shall be stored in dry, ventilated areas until immediately before installation.

## 2 PRODUCTS

## 2.1 MATERIALS

Lead, lead-coated metal, and galvanized steel shall not be used. Any metal listed by SMACNA-02 for a particular item may be used, unless otherwise specified or indicated. Materials shall conform to the requirements



specified below and to the thicknesses and configurations established in SMACNA-02. Different items need not be of the same metal, except that if copper is selected for any exposed item, all exposed items shall be copper.

#### 2.1.1 Accessories

Accessories and other items essential to complete the sheet metal installation, though not specifically indicated or specified, shall be provided.

#### 2.1.2 Aluminum Extrusions

ASTM B 221, Alloy 6063, Temper T5.

#### 2.1.3 Bituminous Cement

Type I asphalt cement conforming to ASTM D 2822 or ASTM D 4586. For coal tar roofing; coal tar cement conforming to ASTM D 4022.

#### 2.1.4 Sealant

Unless otherwise specified, sealant shall be an elastomeric weather resistant sealant as specified in Section 07920 JOINT SEALING.

#### 2.1.5 Fasteners

Fasteners shall be compatible with the fastened material and shall be the type best suited for the application.

#### 2.1.6 Felt

ASTM D 226, Type I.

#### 2.1.7 Polyvinyl Chloride (PVC) Reglets

ASTM D 1784, Class 14333D, 1.9 mm minimum thickness.

#### 2.1.8 Aluminum Alloy Sheet and Plate

ASTM B 209, clear anodized when not exposed to view and colored to match adjacent item(s), such as roofing, to form, alloy, and temper appropriate for use.

#### 2.1.9 Copper

ASTM B 370, Temper H 00.

#### 2.1.10 Stainless Steel

ASTM A 167, Type 302 or 304; fully annealed, dead soft temper.

#### 2.1.11 Solder

ASTM B 32, 95-5 tin-antimony.

### 2.1.12 Through-Wall Flashing

- a. Electro-sheet copper not less than 0.14 kg, factory coated both sides with acid- and alkali-resistant bituminous compound not less than 1.8 kg per square meter or factory covered both sides with asphalt-saturated cotton fabric, asphalt saturated glass-fiber fabric, or with 18 kg reinforced kraft paper bonded with asphalt.
- b. Stainless steel, Type 304, not less than 0.08 mm thick, completely encased by and permanently bonded on both sides to 23 kg high strength bituminized crepe kraft paper, using hot asphalt, heat, and pressure.
- c. 0.09 kg copper sheet, with 0.05 mm of dense, clear, polyethylene sheet bonded to each side of the copper.
- d. Other through-wall flashing material may be used provided the following performance criteria are met.
  - (1) No cracking or flaking when bent 180 degrees over a 0.8 mm mandrel and rebent at the same point over the same mandrel in an opposite direction at 0 degree C.
  - (2) Water vapor permeability not more than 115 ng per Paper second per square meter (2 perms) when tested in accordance with ASTM E 96.
  - (3) Minimum breaking strength of 24 kgf/15 mm width in the weakest direction when tested in accordance with ASTM D 828.
  - (4) No visible deterioration after being subjected to a 400-hour direct weathering test in accordance with ASTM D 822.
  - (5) No shrinkage in length or width and less than 5 percent loss of breaking strength after a 10-day immersion, per ASTM D 543, in 5 percent (by weight) solutions, respectively, of sulfuric acid, hydrochloric acid, sodium hydroxide or saturated lime (calcium hydroxide).

### 2.1.13 Louver Screen

Type III aluminum alloy insect screening conforming to ISWA IWS 089.

## 2.2 LOUVERS

### 2.2.1 General Louver Requirements

All louvers shall be designed and manufactured to the following standards, as applicable: Air Movement and Control Association (AMCA) Standard 500, Publication 511; BSRIA (Building Services Research and Information Association).

### 2.2.2 Un-protected Louver Locations

Louvers within ridge vent system and other areas, as scheduled, not protected by overhang elements shall be prefinished, storm-resistant, visible mullion louver model RS-5300 as manufactured by Construction

Specialties, Inc. or approved equal. Louvers shall be constructed entirely of aluminum with approximate 45 degree blade angle and minimum 50% available free area. Each louver shall include an aluminum mesh screen in a rewirable extruded aluminum frame. Louvers shall be factory primed and finished after assembly with a Kynar 500 resin coating in a color as specified in Section 09915 - COLOR SCHEDULE. The finished assembly shall be capable of withstanding a wind load of 98 kg per square meter minimum. Static pressure drop shall not exceed the following: intake - 8.64 mm water, exhaust - 7.87 mm water; each rated at free area velocity of 5.08 m/sec. (1000 ft./min.). Water penetration shall not exceed 0.01 liters of water per 0.37 square meter section at a velocity of 13 m/s when tested in accordance with BSRIA (Building Services Research and Information Association).

### 2.2.3 Protected Louver Locations

Louvers in areas, as scheduled, protected by overhang elements shall be prefinished visible mullion, drainable-blade louver model A4097 as manufactured by Construction Specialties, Inc. or approved equal. Louvers shall be constructed entirely of aluminum with 45 degree blade angle and minimum 50% available free area. Each louver shall include an aluminum mesh screen in a rewirable extruded aluminum frame. Louvers shall be factory primed and finished after assembly with a Kynar 500 resin coating in a color as specified in Section 09915 - COLOR SCHEDULE. The finished assembly shall be capable of withstanding a wind load of 98 kg per square meter minimum. Intake static pressure drop shall not exceed 5.43mm water at beginning point of water penetration at free area velocity of 326.7 m/min. when tested in accordance with AMCA Publication 511.

### 2.3 GUTTER PROTECTION SYSTEM

Gutter protection system shall be installed in all areas as shown. Gutter protection system shall be the following: 'Gutter Helmet' as manufactured by American Metal Products, (800) 749-6891, or approved equal.

## 3 EXECUTION

### 3.1 GENERAL

Items such as gutters, downspouts and louvers shall be fabricated in conformance with SMACNA-02 and as indicated. Unless otherwise specified or indicated, exposed edges shall be folded back to form a 13 mm hem on the concealed side, and bottom edges of exposed vertical surfaces shall be angled to form drips. Bituminous cement shall not be placed in contact with roofing membranes other than built-up roofing.

### 3.2 EXPANSION JOINTS

Expansion joints shall be provided as indicated or as specified in SMACNA-02. Expansion joints in continuous sheet metal shall be provided at 12.0 meter intervals for copper and stainless steel and at 9.6 meter intervals for aluminum, except extruded aluminum gravel stops and fasciae which shall have expansion joints at not more than 3.6 meter spacing. Joints shall be evenly spaced. An additional joint shall be provided where the distance between the last expansion joint and the end of the continuous run is more than half the required interval spacing.

### 3.3 PROTECTION OF ALUMINUM

Aluminum shall not be used where it will be in contact with copper or where it will contact water which flows over copper surfaces. Aluminum that will be in contact with wet or pressure-treated wood, mortar, concrete, masonry, or ferrous metals shall be protected against galvanic or corrosive action by one of the following methods:

#### 3.3.1 Paint

Aluminum surfaces shall be solvent cleaned and given one coat of zinc-molybdate primer and one coat of aluminum paint as specified in Section 09900 PAINTING, GENERAL.

#### 3.3.2 Nonabsorptive Tape or Gasket

Nonabsorptive tape or gasket shall be placed between the adjoining surfaces and cemented to the aluminum surface using a cement compatible with aluminum.

### 3.4 CONNECTIONS AND JOINTING

#### 3.4.1 Soldering

Soldering shall apply to copper, and stainless steel items. Edges of sheet metal shall be pretinned before soldering is begun. Soldering shall be done slowly with well heated soldering irons so as to thoroughly heat the seams and completely sweat the solder through the full width of the seam. Edges of stainless steel to be pretinned shall be treated with soldering acid flux. Soldering shall follow immediately after application of the flux. Upon completion of soldering, the acid flux residue shall be thoroughly cleaned from the sheet metal with a water solution of washing soda and rinsed with clean water.

#### 3.4.2 Riveting

Joints in aluminum sheets 1.0 mm or less in thickness shall be mechanically made.

#### 3.4.3 Seaming

Flat-lock and soldered-lap seams shall finish not less than 25 mm wide. Unsoldered plain-lap seams shall lap not less than 75 mm unless otherwise specified. Flat seams shall be made in the direction of the flow.

### 3.5 CLEATS

A continuous cleat shall be provided where indicated or specified to secure loose edges of the sheet metalwork. Butt joints of cleats shall be spaced approximately 3 mm apart. The cleat shall be fastened to supporting wood construction with nails evenly spaced not over 300 mm on centers. Where the fastening is to be made to concrete or masonry, screws shall be used and shall be driven in expansion shields set in concrete or masonry.

### 3.6 GUTTERS AND DOWNSPOUTS

Gutters and downspouts shall be installed as indicated. Gutters shall be supported by continuous cleats. Downspouts shall be rigidly attached to the building. Supports for downspouts shall be spaced according to manufacturer's recommendations.

### 3.7 FLASHINGS

Flashings shall be installed at locations indicated and as specified below. Sealing shall be according to the flashing manufacturer's recommendations. Flashings shall be installed at intersections of roof with vertical surfaces and at projections through roof, except that flashing for heating and plumbing, including piping, roof, and floor drains, and for electrical conduit projections through roof or walls are specified in other sections. Except as otherwise indicated, counter flashings shall be provided over base flashings. Perforations in flashings made by masonry anchors shall be covered up by an application of bituminous plastic cement at the perforation. Flashing shall be installed on top of joint reinforcement. Flashing shall be formed to direct water to the outside of the system.

#### 3.7.1 Base Flashing

Metal base flashing shall be coordinated with roofing work. Metal base flashing shall be set in plastic bituminous cement over the roofing membrane, nailed to nailing strip, and secured in place on the roof side with nails spaced not more than 75 mm on centers. Metal base flashing shall not be used on built-up roofing.

#### 3.7.2 Counter Flashings

Except as otherwise indicated, counter flashings shall be provided over base flashings. Counter flashing shall be installed as shown on the drawings or, if not shown, in SMACNA-02. Where bituminous base flashings are provided, the counter flashing shall extend down as close as practicable to the top of the cant strip. Counter flashing shall be factory formed to provide spring action against the base flashing.

#### 3.7.3 Stepped Flashing

Stepped flashing shall be installed where sloping roofs surfaced with shingles abut vertical surfaces. Separate pieces of base flashing shall be placed in alternate shingle courses.

#### 3.7.4 Through-Wall Flashing

Through-wall flashing includes sill, lintel, and spandrel flashing. The flashing shall be laid with a layer of mortar above and below the flashing so that the total thickness of the two layers of the mortar and flashing are the same thickness as the regular mortar joints. Flashing shall not extend further into the masonry backup wall than the first mortar joint. Joints in flashing shall be lapped and sealed. Flashing shall be one piece for lintels and sills. End dams shall be constructed at each end of flashing at sills and other areas where flashing terminates against other materials subject to water damage.

#### 3.7.4.1 Lintel Flashing

Lintel flashing shall extend the full length of lintel. Flashing shall extend through the wall one masonry course above the lintels and shall be bent down over the vertical leg of the outer steel lintel angle not less than 50 mm, or shall be applied over top of masonry and precast concrete lintels. Bedjoints of lintels at control joints shall be underlaid with sheet metal bond breaker.

#### 3.7.4.2 Sill Flashing

Sill flashing shall extend the full width of the sill and not less than 100 mm beyond ends of sill except at control joint where the flashing shall be terminated at the end of the sill.

#### 3.7.5 Valley Flashing

Valley flashing shall be installed as specified in SMACNA-02 and as indicated.

#### 3.8 GRAVEL STOPS AND FASCIA

Gravel stops and fascia shall be fabricated and installed as indicated and in accordance with SMACNA-02.

#### 3.9 INSTALLATION OF LOUVERS

Louvers shall be rigidly attached to the supporting construction. The installation shall be rain-tight. Louver screen shall be installed as indicated.

#### 3.10 REGLETS

Reglets shall be a factory fabricated product of proven design, complete with fittings and special shapes as required. Open-type reglets shall be filled with fiberboard or other suitable separator to prevent crushing of the slot during installation. Reglet plugs shall be spaced not over 300 mm on centers and reglet grooves shall be filled with sealant. Friction or slot-type reglets shall have metal flashings inserted the full depth of slot and shall be lightly punched every 300 mm to crimp the reglet and counter flashing together. Polyvinyl chloride reglets shall be sealed with the manufacturer's recommended sealant.

#### 3.11 CONTRACTOR QUALITY CONTROL

The Contractor shall establish and maintain a quality control procedure for sheet metal used in conjunction with roofing to assure compliance of the installed sheet metalwork with the contract requirements. Any work found not to be in compliance with the contract shall be promptly removed and replaced or corrected in an approved manner. Quality control shall include, but not be limited to, the following:

- a. Observation of environmental conditions; number and skill level of sheet metal workers; condition of substrate.
- b. Verification of compliance of materials before, during, and after installation.

- c. Inspection of sheet metalwork for proper size and thickness, fastening and joining, and proper installation.

The actual quality control observations and inspections shall be documented and a copy of the documentation furnished to the Contracting Officer at the end of each day.

## SECTION 07900

## JOINT SEALING

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 509	(1994) Elastomeric Cellular Preformed Gasket and Sealing Material
ASTM C 570	(1995) Oil- and Resin-Base Caulking Compound for Building Construction
ASTM C 734	(1993) Low-Temperature Flexibility of Latex Sealants After Artificial Weathering
ASTM C 834	(1995) Latex Sealants
ASTM C 920	(1994) Elastomeric Joint Sealants
ASTM C 1085	(1991) Butyl Rubber-Based Solvent-Release Sealants
ASTM C 1184	(1995) Structural Silicone-Sealants
ASTM D 217	(1994) Cone Penetration of Lubricating Grease
ASTM D 1056	(1991) Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D 1565	(1981; R 1990) Flexible Cellular Materials - Vinyl Chloride Polymers and Copolymers (Open-Cell Foam)
ASTM E 84	(1996a) Surface Burning Characteristics of Building Materials

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

SD-01 Data

Backing; FIO. Bond-Breaker; FIO.

Sealant; FIO.



Manufacturer's descriptive data including storage requirements, shelf life, curing time, instructions for mixing and application, and primer data (if required). A copy of the Material Safety Data Sheet shall be provided for each solvent, primer or sealant material.

#### SD-13 Certificates

Sealant; FIO.

Certificates of compliance stating that the materials conform to the specified requirements.

### 1.3 ENVIRONMENTAL REQUIREMENTS

The ambient temperature shall be within the limits of 4 to 32 degrees C when the sealants are applied.

### 1.4 DELIVERY AND STORAGE

Materials shall be delivered to the job in the manufacturer's original unopened containers. The container label or accompanying data sheet shall include the following information as applicable: manufacturer, name of material, formula or specification number, lot number, color, date of manufacture, mixing instructions, shelf life, and curing time at the standard conditions for laboratory tests. Materials shall be handled and stored to prevent inclusion of foreign materials. Materials shall be stored at temperatures between 4 and 32 degrees C unless otherwise specified by the manufacturer.

## 2 PRODUCTS

### 2.1 BACKING

Backing shall be 25 to 33 percent oversize for closed cell and 40 to 50 percent oversize for open cell material, unless otherwise indicated.

#### 2.1.1 Rubber

Cellular rubber sponge backing shall be ASTM D 1056, Type 1, open cell, or Type 2, closed cell, Class A, Grade as appropriate, round cross section.

#### 2.1.2 PVC

Polyvinyl chloride (PVC) backing shall be ASTM D 1565, Grade VO 12, open-cell foam, round cross section.

#### 2.1.3 Synthetic Rubber

Synthetic rubber backing shall be ASTM C 509, Option I, Type I preformed rods or tubes.

#### 2.1.4 Neoprene

Neoprene backing shall be ASTM D 1056, closed cell expanded neoprene cord Type 2, Class C, Grade 2C2 or open cell neoprene sponge Type 1, Class C, Grade 1C3.

## 2.2 BOND-BREAKER

Bond-breaker shall be as recommended by the sealant manufacturer to prevent adhesion of the sealant to backing or to bottom of the joint.

## 2.3 PRIMER

Primer shall be non-staining type as recommended by sealant manufacturer for the application.

## 2.4 CAULKING

Oil- and resin-based caulking shall be ASTM C 570, Type and Use as to the appropriate application.

## 2.5 SEALANT

### 2.5.1 LATEX

Latex Sealant shall be ASTM C 834.

### 2.5.2 ELASTOMERIC

Elastomeric sealants shall conform to ASTM C 920 and the following:

- a. Polysulfide Sealant: Type S, Grade NS, Class 25, Use G.
- b. Polyurethane sealant: Grade P, Class 25, Use T.
- c. Silicone sealant: Type S, Grade NS, Class 25, Use NT.
- d. Structural silicone sealant: ASTM C 1184, Type S, Use G.

### 2.5.3 ACOUSTICAL

Rubber or polymer-based acoustical sealant shall have a flame spread of 25 or less and a smoke developed rating of 50 or less when tested in accordance with ASTM E 84. Acoustical sealant shall have a consistency of 250 to 310 when tested in accordance with ASTM D 217, and shall remain flexible and adhesive after 500 hours of accelerated weathering as specified in ASTM C 734, and shall be non-staining.

### 2.5.4 BUTYL

Butyl sealant shall be ASTM C 1085.

### 2.5.5 PREFORMED

Preformed sealant shall be polybutylene or isoprene-butylene based pressure sensitive weather resistant tape or bead sealant capable of sealing out moisture, air and dust when installed as recommended by the manufacturer. At temperatures from minus 34 to plus 71 degrees C, the sealant shall be non-bleeding and shall have no loss of adhesion.

#### 2.5.5.1 Tape

Tape sealant: cross-section dimensions shall be as required.

#### 2.5.5.2 Bead

Bead sealant: cross-section dimensions shall be as required.

#### 2.5.5.3 Foam Strip

Foam strip shall be polyurethane foam; cross-section dimensions shall be as required. Foam strip shall be capable of sealing out moisture, air, and dust when installed and compressed as recommended by the manufacturer. Service temperature shall be minus 40 to plus 135 degrees C. Untreated strips shall be furnished with adhesive to hold them in place. Adhesive shall not stain or bleed into adjacent finishes. Treated strips shall be saturated with butylene waterproofing or impregnated with asphalt.

### 2.6 SOLVENTS AND CLEANING AGENTS

Solvents, cleaning agents, and accessory materials shall be provided as recommended by the manufacturer.

## 3 EXECUTION

### 3.1 GENERAL

#### 3.1.1 Surface Preparation

The surfaces of joints to receive sealant or caulk shall be free of all frost, condensation and moisture. Oil, grease, dirt, chalk, particles of mortar, dust, loose rust, loose mill scale, and other foreign substances shall be removed from surfaces of joints to be in contact with the sealant. Oil and grease shall be removed with solvent and surfaces shall be wiped dry with clean cloths. For surface types not listed below, the sealant manufacturer shall be contacted for specific recommendations.

#### 3.1.2 Concrete and Masonry Surfaces

Where surfaces have been treated with curing compounds, oil, or other such materials, the materials shall be removed by sandblasting or wire brushing. Laitance, efflorescence and loose mortar shall be removed from the joint cavity.

#### 3.1.3 Steel Surfaces

Steel surfaces to be in contact with sealant shall be sandblasted or, if sandblasting would not be practical or would damage adjacent finish work, the metal shall be scraped and wire brushed to remove loose mill scale. Protective coatings on steel surfaces shall be removed by sandblasting or by a solvent that leaves no residue.

#### 3.1.4 Aluminum Surfaces

Aluminum surfaces to be in contact with sealants shall be cleaned of temporary protective coatings. When masking tape is used for a protective cover, the tape and any residual adhesive shall be removed just prior to

applying the sealant. Solvents used to remove protective coating shall be as recommended by the manufacturer of the aluminum work and shall be non-staining.

### 3.1.5 Wood Surfaces

Wood surfaces to be in contact with sealants shall be free of splinters and sawdust or other loose particles.

## 3.2 APPLICATION

### 3.2.1 Masking Tape

Masking tape may be placed on the finish surface on one or both sides of a joint cavity to protect adjacent finish surfaces from primer or sealant smears. Masking tape shall be removed within 10 minutes after joint has been filled and tooled.

### 3.2.2 Backing

Backing shall be installed to provide the indicated sealant depth. The installation tool shall be shaped to avoid puncturing the backing.

### 3.2.3 Bond-Breaker

Bond-breaker shall be applied to fully cover the bottom of the joint without contaminating the sides where sealant adhesion is required.

### 3.2.4 Primer

Primer shall be used on concrete masonry units, wood, or other porous surfaces in accordance with instructions furnished with the sealant. Primer shall be applied to the joint surfaces to be sealed. Surfaces adjacent to joints shall not be primed.

### 3.2.5 Sealant

Sealant shall be used before expiration of shelf life. Multi-component sealants shall be mixed according to manufacturer's printed instructions. Sealant in guns shall be applied with a nozzle of proper size to fit the width of joint. Joints shall be sealed as detailed in the drawings. Sealant shall be forced into joints with sufficient pressure to expel air and fill the groove solidly. Sealant shall be installed to the indicated depth without displacing the backing. Unless otherwise indicated, specified, or recommended by the manufacturer, the installed sealant shall be dry tooled to produce a uniformly smooth surface free of wrinkles and to ensure full adhesion to the sides of the joint; the use of solvents, soapy water, etc., will not be allowed. Sealants shall be installed free of air pockets, foreign embedded matter, ridges and sags. Sealer shall be applied over the sealant when and as specified by the sealant manufacturer.

## 3.3 CLEANING

The surfaces adjoining the sealed joints shall be cleaned of smears and other soiling resulting from the sealant application as work progresses.

## SECTION 08110

## STEEL DOORS AND FRAMES

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 236	(1989; R 1993) Steady-State Thermal Performance of Building Assemblies by Means of a Guarded Hot Box
ASTM C 976	(1990) Thermal Performance of Building Assemblies by Means of a Calibrated Hot Box
ASTM D 2863	(1991) Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
ASTM E 283	(1991) Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen

## DOOR AND HARDWARE INSTITUTE (DHI)

DHI A115.1G	(1994) Installation Guide for Doors and Hardware
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## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80	NFPA 101 (1997) Safety to Life from Fire in Buildings and Structures
NFPA 252	(1995) Fire Tests of Door Assemblies

## STEEL DOOR INSTITUTE (SDOI)

SDOI SDI-100	(1991) Standard Steel Doors and Frames
SDOI SDI-106	(1996) Standard Door Type Nomenclature
SDOI SDI-107	(1984) Hardware on Steel Doors (Reinforcement - Application)

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

## SD-04 Drawings

Steel Doors and Frames; GA.

Drawings using standard door type nomenclature in accordance with SDOI SDI-106 indicating the location of each door and frame, elevation of each model of door and frame, details of construction, method of assembling sections, location and extent of hardware reinforcement, hardware locations, type and location of anchors for frames, and thicknesses of metal. Drawings shall include catalog cuts or descriptive data for the doors, frames, and weatherstripping including air infiltration data and manufacturers printed instructions.

## SD-09 Reports

Fire Rated Doors; FIO.

A letter by a nationally recognized testing laboratory which identifies the product manufacturer, type, and model; certifying that the laboratory has tested a sample assembly in accordance with NFPA 252 and issued a current listing for same.

## SD-13 Certificates

Fire Rated Doors; FIO. Thermal Insulated Doors; FIO.

- a. Certification of Oversized Fire Doors: Certificates of compliance in accordance with the requirements of NFPA 252 for fire doors exceeding the sizes for which label service is available.
- b. Certification of Thermal Insulating] Rating: Certification or test report for thermal insulated doors shall show compliance with the specified requirements. The certification, or test report, shall list the parameters and the type of hardware and perimeter seals used to achieve the rating.

## 1.3 DELIVERY AND STORAGE

During shipment, welded unit type frames shall be strapped together in pairs with heads at opposite ends or shall be provided with temporary steel spreaders at the bottom of each frame; and knockdown type frames shall be securely strapped in bundles. Materials shall be delivered to the site in undamaged condition, and stored out of contact with the ground and under a weathertight covering permitting air circulation. Doors and assembled frames shall be stored in an upright position in accordance with DHI A115.1G. Abraded, scarred, or rusty areas shall be cleaned and touched up with matching finishes.

## 1.4 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period shall be provided.

## 2 PRODUCTS

### 2.1 DOORS AND FRAMES

Doors and frames shall be factory fabricated in accordance with SDOI SDI-100 and the additional requirements specified herein. Door grade shall be heavy duty (Grade II) unless otherwise indicated on the door and door frame schedules. Indicated interior doors and frames shall be designation A40 galvanized. Doors and frames shall be prepared to receive hardware conforming to the templates and information provided under Section 08700 BUILDERS' HARDWARE. Doors and frames shall be reinforced, drilled, and tapped to receive mortised hinges, locks, latches, and flush bolts as required. Doors and frames shall be reinforced for surface applied hardware. Frames shall be welded type. Door frames shall be furnished with a minimum of three jamb anchors and one floor anchor per jamb. Anchors shall be not less than 1.2 mm (18 gauge) steel or 4.5 mm (7 gauge) diameter wire. For wall conditions that do not allow the use of a floor anchor, an additional jamb anchor shall be provided. Rubber silencers shall be furnished for installation into factory predrilled holes in door frames; adhesively applied silencers are not acceptable. Where frames are installed in plaster or masonry walls, plaster guards shall be provided on door frames at hinges and strikes. Full glass doors shall conform to SDOI SDI-100, Model 3, and shall include provisions for glazing. Reinforcing of door assemblies for closers and other required hardware shall be in accordance with SDOI SDI-100 and the conditions of the fire door assembly listing when applicable. Exterior doors shall have top edges closed flush and sealed against water penetration.

### 2.2 FIRE RATED DOORS

Fire rated door assemblies shall bear the listing identification label of a nationally recognized testing laboratory qualified to perform tests of fire door assemblies in accordance with NFPA 252 and having a listing for the tested assemblies. The fire resistance rating shall be as shown. Doors exceeding the sizes for which listing label service is offered shall be in accordance with NFPA 252. Listing identification labels shall be constructed and permanently applied by a method which results in their destruction should they be removed.

### 2.3 THERMAL INSULATED DOORS

The interior of thermal insulated doors shall be completely filled with rigid plastic foam permanently bonded to each face panel. The thermal conductance (U-value) through the door shall not exceed 2.33 W/sq m times K when tested as an operational assembly in accordance with ASTM C 236 or ASTM C 976. Doors with cellular plastic cores shall have a minimum oxygen index rating of 22 percent when tested in accordance with ASTM D 2863.

### 2.4 WEATHERSTRIPPING

Unless otherwise specified in Section 08700 BUILDERS' HARDWARE, weatherstripping shall be as follows: Weatherstripping for head and jamb shall be manufacturer's standard elastomeric type of synthetic rubber, vinyl, or neoprene and shall be installed at the factory or on the jobsite in accordance with the door frame manufacturer's recommendations. Weatherstripping for bottom of doors shall be as shown. Air leakage rate of

weatherstripping shall not exceed 0.31 l/s per linear meter of crack when tested in accordance with ASTM E 283 at standard test conditions.

## 2.5 TRANSOM AND SIDELIGHT PANELS

Panels for transom and/or sidelight shall be constructed in accordance with SDOI SDI-100. Panels shall be nonremovable from the outside of exterior doors or the unsecure side of interior doors.

## 2.6 LOUVERS

Where indicated, doors shall be provided with full louvers or louver sections, as shown. Louvers shall be sightproof type inserted into the door. Pierced louvers shall not be used on exterior doors. Inserted louvers shall be stationary. Louvers shall be nonremovable from the outside of exterior doors or the unsecure side of interior doors. Insect screens shall be a removable type with 18 by 16 mesh aluminum or bronze cloth. Full louver doors shall be in accordance with SDOI SDI-100, Grade III, Model 3.

## 2.7 GLAZING

Glazing shall be as specified in Section 08810 GLASS AND GLAZING. Removable glazing beads shall be screw-on or snap-on type.

# 3 EXECUTION

## 3.1 INSTALLATION

Installation shall be in accordance with DHI A115.1G. Preparation for surface applied hardware shall be in accordance with SDOI SDI-107. Rubber silencers shall be installed in door frames after finish painting has been completed; adhesively applied silencers are not acceptable. Weatherstripping shall be installed at exterior door openings to provide a weathertight installation. Installation and operational characteristics of fire doors shall be in accordance with NFPA 80, NFPA 80A and NFPA 101. Hollow metal door frames shall be solid grouted [in [masonry walls] [solid plaster walls] [steel stud walls]] [as shown].

### 3.1.1 Thermal Insulated Doors

Hardware and perimeter seals shall be adjusted for proper operation. Doors shall be sealed weathertight after installation of hardware and shall be in accordance with Section 07920 JOINT SEALING.

## 3.2 FIELD PAINTED FINISH

Steel doors and frames shall be field painted in accordance with Section 09900 PAINTING, GENERAL. Weatherstrips shall be protected from paint. Finish shall be free of scratches or other blemishes. Color shall be in accordance with Section 09915 COLOR SCHEDULE.



## SECTION 08120

## ALUMINUM DOORS AND FRAMES

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## ALUMINUM ASSOCIATION (AA)

AA DAF-45 (1980; R 1993) Designation System for Aluminum Finishes

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 209 (1996) Aluminum and Aluminum-Alloy Sheet and Plate

ASTM B 221 (1996) Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes

ASTM E 283 (1991) Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen

ASTM E 330 (1990) Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference

ASTM E 331 (1996) Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference

## 1.2 SYSTEM DESCRIPTION

Swing-type aluminum doors and frames, of size and design shown on the drawings, shall be provided at the locations indicated. Doors shall be furnished complete with frames, subframes, transoms, adjoining sidelights, adjoining window wall, trim, and other accessories indicated and specified.

## 1.3 PERFORMANCE REQUIREMENTS

## 1.3.1 Wind Load Performance

Doors and frames shall be of sufficient strength to withstand a design wind load of 98 kg per square meter of supported area with a deflection of not more than 1/175 times the length of the member. Doors shall be tested in accordance with ASTM E 330 at a pressure not less than 1.5 times the design load.

### 1.3.2 Water Penetration Performance

Frames and fixed areas, and non-handicap complying doors shall have no water penetration when tested in accordance with ASTM E 331 at a pressure of 383 Pa.

### 1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

#### SD-01 Data

Aluminum Doors and Frames; FIO.

Manufacturer's descriptive data and catalog cuts including air-infiltration data.

#### SD-04 Drawings

Aluminum Doors and Frames; GA.

A schedule showing the location of each door shall be included with the drawings. Drawings showing elevations of each door and frame type, details and method of anchorage, details of construction, location and installation of hardware, shape and thickness of materials, and details of joints and connections.

#### SD-06 Instructions

Installation; FIO. Cleaning; FIO.

Manufacturer's installation instructions and cleaning instructions.

#### SD-09 Reports

Full-Glazed and Flush Doors; FIO.

For full-glazed and flush doors, certified test reports from an independent testing laboratory, stating that doors are identical in design, materials, and construction to a door that has been tested and meets all test and specified requirements.

#### SD-14 Samples

Finishes; GA.

Samples of the [color anodized coating, showing the extreme color range] [painted finish].

### 1.5 DELIVERY AND STORAGE

Materials delivered to the jobsite shall be inspected for damage, and shall be unloaded with a minimum of handling. Storage shall be in a dry location with adequate ventilation, free from dust, water, and other contaminants, and which permits easy access for inspecting and handling. Materials shall

be neatly stored on the floor, properly stacked on nonabsorptive strips or wood platforms. Doors and frames shall not be covered with tarps, polyethylene film, or similar coverings.

## 1.6 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one-year period shall be provided.

## 2 PRODUCTS

### 2.1 ALUMINUM DOORS AND FRAMES

Extrusions shall comply with ASTM B 221, Alloy 6063-T5 except alloy used for anodized color coatings shall be required to produce the specified color. Aluminum sheets and strips shall comply with ASTM B 209, alloy and temper best suited for the purpose. Fasteners shall be hard aluminum or stainless steel.

#### 2.1.1 Finishes

Finish shall be color anodized. Color anodized finish shall be AA-M10C22A42 in accordance with the requirements of AA DAF-45. Color shall be in accordance with Section 09915 COLOR SCHEDULE.

#### 2.1.2 Welding and Fastening

Where possible, welds shall be located on unexposed surfaces. Welds required on exposed surfaces shall be smoothly dressed. Welding shall produce a uniform texture and color in the finished work, free of flux and spatter. Exposed screws or bolts will be permitted only at inconspicuous locations and shall have heads countersunk.

#### 2.1.3 Anchors

Anchors shall be stainless steel or steel with a hot-dipped galvanized finish. Anchors of the sizes and shapes required shall be provided for securing aluminum frames to adjacent construction. Anchors shall be placed near top and bottom of each jamb and at intermediate points not more than 625 mm apart. Transom bars shall be anchored at ends, and mullions shall be anchored at head and sill. Where indicated on the drawings, vertical mullion reinforcement shall be of sufficient length to extend up to the overhead structural slab or framing and be securely attached thereto. The bottom of each frame shall be anchored to the rough floor construction with 2.4 mm thick stainless steel angle clips secured to the back of each jamb and to floor construction. Stainless steel bolts and expansion rivets shall be used for fastening clip anchors. Freestanding door frames shall be reinforced and securely anchored to floor construction.

#### 2.1.4 Provisions For Hardware

Hardware for aluminum doors is specified in Section 08700 BUILDERS' HARDWARE. Doors and frames shall be cut, reinforced, drilled, and tapped at the factory to receive template hardware. Reinforcement shall be provided in the core of doors as required to receive locks, door closers, and other hardware. Doors to receive surface applied hardware shall be reinforced as required.

### 2.1.5 Provisions For Glazing

Glazing shall be as specified in Section 08810 GLASS AND GLAZING. Metal glazing beads, vinyl inserts, and glazing gaskets shall be provided for securing glass. Glass stops shall be tamperproof on exterior side.

### 2.1.6 Weatherstripping

Weatherstripping shall be continuous silicone-treated wool pile type, or a type recommended by the door manufacturer, and shall be provided on head and jamb of exterior doors. Weatherstripping for bottom of doors shall be as shown. Weatherstripping shall be easily replaced without special tools, and shall be adjustable at meeting stiles of pairs of doors. Air leakage rate of weatherstripping shall not exceed 0.775 L/s per lineal meter of crack when tested in accordance with ASTM E 283 at standard test conditions.

## 2.2 FABRICATION OF ALUMINUM FRAMES

Frames shall be fabricated of extruded aluminum shapes to contours as shown on the drawings. Shapes shown are representations of design, function, and required profile. Dimensions shown are minimum. Shapes of equivalent design may be submitted, subject to approval of samples. Minimum metal wall thickness shall be 2.29 mm, except glazing beads, moldings, and trim shall be not less than 1.27 mm. Frames that are to receive glass shall have removable snap-on glass stops and glazing beads. Joints in frame members shall be milled to a hairline watertight fit, reinforced, and secured mechanically by steel clip arrangement or by screw spline attachment.

## 2.3 FABRICATION OF ALUMINUM DOORS

### 2.3.1 Sizes, Clearances, and Edge Treatment

Doors shall be not less than 44.4 mm thick. Clearances shall be 1.6 mm at hinge stiles, 3 mm at lock stiles and top rails, and 5 mm at floors and thresholds. Single-acting doors shall be beveled 3 mm at lock and meeting stile edges. Double-acting doors shall have rounded edges at hinge stile, lock stile, and meeting stile edges.

#### 2.3.1.1 Flush Doors

Doors shall be provided with fixed louvers where so indicated. Doors shall be double-glazed and shall have a minimum total average unit thermal resistance of 0.34 square meter degree K per W. Facing sheets shall have an embossed pattern and shall be of the color and finish specified. Doors shall have a core of foamed-in-place self-extinguishing urethane. Core shall be surrounded at edges and openings with extruded aluminum shapes. Facing sheets shall be 0.79 mm thick aluminum bonded to 3 mm thick tempered hardboard backing, or shall be 1.27 mm thick aluminum. Facing sheets shall be bonded to the core and interlocked with the extruded edge members.

### 3 EXECUTION

#### 3.1 INSTALLATION OF DOORS, FRAMES, AND ACCESSORIES

##### 3.1.1 Protection of Aluminum

Aluminum shall not be used where it will be in contact with copper or where it will contact water which flows over copper surfaces. Aluminum that will be in contact with wet or pressure-treated wood, mortar, concrete, masonry, or ferrous metals shall be protected against galvanic or corrosive action by one of the following methods.

###### 3.1.1.1 Paint

Aluminum surfaces to be protected shall be solvent cleaned and given a coat of zinc-molybdate primer and one coat of aluminum paint.

###### 3.1.1.2 Nonabsorptive Tape or Gasket

Nonabsorptive tape or gasket shall be placed between the adjoining surfaces and shall be cemented to the aluminum surface using a cement compatible with aluminum.

##### 3.1.2 Installation

Frames and framing members shall be accurately set in position to receive doors, transoms, and adjoining sidelights. Frames shall be plumb, square, level, and in alignment, and securely anchored to adjacent construction. Metal-to-metal joints between framing members shall be sealed as specified in Section 07900 JOINT SEALING. Doors shall be accurately hung with proper clearances, and adjusted to operate properly. Protective coverings if provided shall be removed and the doors and frames shall be thoroughly cleaned.

## SECTION 08210

## WOOD DOORS

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## ARCHITECTURAL WOODWORK INSTITUTE (AWI)

AWI-02 (1994) Architectural Woodwork Quality Standards, Guide Specifications and Quality Certification Program

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80 (1995) Fire Doors and Windows

NFPA 101 (1997) Safety to Life from Fire in Buildings and Structures

NFPA 252 (1995) Fire Tests of Door Assemblies

## NATIONAL WOOD WINDOW &amp; DOOR ASSOCIATION (NWWDA)

NWWDA I.S. 1-A (1993) Architectural Wood Flush Doors

NWWDA I.S. 4 (1994) Water-Repellent Preservative Non-Pressure Treatment for Millwork

## 1.2 GENERAL REQUIREMENTS

## 1.2.1 Standard Products

Doors shall be of the type, size, and design indicated on the drawings, and shall be the standard products of manufacturers regularly engaged in the manufacture of wood doors.

## 1.2.2 Marking

Each door shall bear a stamp, brand, or other identifying mark indicating quality and construction of the door. The identifying mark or a separate certification shall include identification of the standard on which construction of the door is based, identity of the manufacturing plant, identification of the standard under which preservative treatment, if used, was made, and identification of the doors having a Type I glue bond.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The

following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

SD-04 Drawings

Wood Doors and Frames; GA.

Drawings indicating the location of each door, elevation of each type of door, details of construction, marks to be used to identify the doors, and location and extent of hardware blocking. Drawings shall include catalog cuts or descriptive data for doors, weatherstripping, flashing, and thresholds to be used.

SD-06 Instructions

Fire Doors; FIO.

Manufacturers preprinted installation and touch-up instructions.

SD-13 Certificates

Fire Rated Doors; FIO. Adhesives; FIO.

Certificates for oversize fire doors and/or door/frame assemblies stating that the doors are identical in design, materials, and construction to a door that has been tested and meets the requirements for the class indicated. Certificate stating that adhesives used for proposed doors do not contain any formaldehyde.

SD-14 Samples

Factory Coated Natural Finish; GA.

Samples of factory applied natural finish.

1.4 STORAGE

Doors shall be stored in fully covered areas and protected from damage and from extremes in temperature and humidity. Doors shall be stored on supports to prevent warping or twisting, and to provide ventilation. Factory cartons or wrappers shall be kept intact until installation.

1.5 HARDWARE

Hardware, including weatherstripping and thresholds, is specified in Section 08700 BUILDERS' HARDWARE.

1.6 GLAZING

Glazing is specified in Section 08810 GLASS AND GLAZING.

1.7 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period shall be provided.

## 2 PRODUCTS

### 2.1 GENERAL FABRICATION REQUIREMENTS

#### 2.1.1 Edge Sealing

Wood end-grain exposed at edges of doors shall be sealed prior to shipment.

#### 2.1.2 Preservative Treatment

Exterior softwood doors shall be water-repellent preservative treated in accordance with NWWDA I.S. 4.

#### 2.1.3 Adhesives

Adhesives shall be in accordance with NWWDA I.S. 1-A, requirements for Type I Bond Doors (waterproof) for exterior doors and requirements for Type II Bond Doors (water-repellent) for interior doors. Adhesive for doors to receive a transparent finish shall be nonstaining. Adhesives shall contain no formaldehydes.

#### 2.1.4 Prefitting

Doors shall be furnished prefitted or unfitted at the option of the Contractor, except plastic laminate clad doors shall be furnished prefit in accordance with the standards under which they are produced.

### 2.2 FLUSH DOORS

Flush doors shall be solid core and shall conform to NWWDA I.S. 1-A, except for the one year acclimatization requirement in paragraph T-2, which shall not apply. Wood doors shall be 5-ply construction with faces, stiles, and rails bonded to the cores.

#### 2.2.1 Core Construction

##### 2.2.1.1 Solid Cores

Door construction shall be glued wood block core or mineral core with vertical and horizontal edges bonded to the core. Blocking and hardware reinforcements for mineral core doors shall be blocking option in accordance with NWWDA I.S. 1-A.

#### 2.2.2 Face Panels

##### 2.2.2.1 Natural Finished Wood Veneer Doors

Veneer doors to receive natural finish shall be Custom Grade red oak veneer in accordance with NWWDA I.S. 1-A. Vertical stile strips shall be selected to provide edges of the same species and/or color as the face veneer. Door finish shall be in accordance with paragraph FIELD FINISHING.

### 2.3 PANEL AND LOUVER DOORS

Panel and louver doors shall conform to AWI-02 Section 1400.



### 2.3.1 Louvers

Slats shall be not less than 6 mm thick. A center mullion shall be provided for flat slat louvers 500 mm or more in width, and for V-slat louvers 600 mm or more in width. Doors shall be adequately blocked to provide solid anchorage for the louvers.

## 2.4 FIRE RATED DOORS

Fire rated door assemblies shall bear the listing identification label of a nationally recognized testing laboratory qualified to perform tests of fire door assemblies in accordance with NFPA 252 and having a listing for the tested assemblies. The specific time interval rating on the labels shall be as shown. Door assemblies shall be in accordance with NFPA 80. Listing identification on labels shall be constructed and permanently applied by a method which results in their destruction should they be removed. Fire rated doors shall be mineral core or staved lumber core.

### 2.4.1 Reinforcement Blocking

Fire rated doors shall be provided, as required, with hardware reinforcement blocking, and top, bottom, and intermediate rail blocking. Lock blocks shall be not less than 125 mm by 450 mm. Reinforcement blocking shall be in compliance with the manufacturer's labeling requirements. Reinforcement blocking shall not be of mineral material.

### 2.4.2 Stile Edges

Composite fire rated doors shall be provided with vertical stile edges that do not contain fire retardant salts. Vertical stiles shall be of the same species and/or color as the face veneer.

## 2.5 MOULDING AND EDGING

Moulding and edging shall be as shown. Wood species for transparent finished doors shall be compatible with veneer.

## 2.6 INSERT LOUVERS

Where indicated, doors shall be provided with sightproof insert louvers. Louvers shall be stationary or adjustable as shown. Blades shall be welded or tenoned to the frame and the entire assembly fastened to the door with metal or wood moldings on both sides as shown. The frame shall be nonremovable from the outside of the door.

## 3 EXECUTION

### 3.1 INSTALLATION OF DOORS

#### 3.1.1 General Use Doors

Doors shall be fit, hung, and trimmed as required. Door shall have a clearance of 3 mm at the sides and top and shall have a bottom clearance of 6 mm over thresholds and 13 mm at other locations unless otherwise shown. The lock edge or both edges of doors shall be beveled at the rate of 3 mm in 50 mm. Cuts made on the job shall be sealed immediately after cutting, using a clear varnish or sealer. Bottom of doors shall be undercut to allow

clear door swing over carpeted areas. Vertical edges of doors which have not been rounded or beveled at the factory shall be eased when the doors are installed.

### 3.1.2 Fire Doors

Installation, hardware, and operational characteristics shall conform to NFPA 80 and NFPA 101 and shall be in strict conformance with the manufacturer's printed instructions. Properly sized pilot holes shall be drilled for screws in door edges. Factory applied labels shall remain intact where installed. Labeled hinge stile edge and top edge of door shall not be trimmed. Lockstile edge and bottom edge may be trimmed only to the extent recommended by the door manufacturer.

### 3.2 INSTALLATION OF WOOD FRAMES

Frames shall be set plumb and square, and rigidly anchored in place securely seated to floor using finish type nails. Double wedge blocking shall be provided near the top, bottom, and mid-point of each jamb.

### 3.3 FIELD FINISHING

Doors to receive field finishing, whether paint or natural finish, shall be factory primed or sealed, as required, and then shall be finished in accordance with Section 09900 PAINTING, GENERAL. Factory applied sealer shall not prevent doors from accepting field stain and finish. Color shall be in accordance with Section 09915 - COLOR SCHEDULE. Field touch-up of factory finishes shall be in accordance with manufacturer's instructions.

## SECTION 08520

## ALUMINUM WINDOWS

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## ALUMINUM ASSOCIATION (AA)

AA DAF-45 (1980) Designation System for Aluminum Finishes

## AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 101 (1993) Voluntary Specifications for Aluminum and Poly(Vinyl Chloride) (PVC) Prime Windows and Glass Doors

AAMA 1503.1 (1988) Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 283 (1991) Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen

ASTM E 330 (1990) Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference

ASTM E 547 (1993) Water Penetration of Exterior Windows, Curtain Walls, and Doors by Cyclic Static Air Pressure Differential

## INSECT SCREENING WEAVERS ASSOCIATION (ISWA)

ISWA IWS 089 (1990) Recommended Standards and Specifications for Insect Wire Screening (Wire Fabric)

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101 (1994) Safety to Life from Fire in Buildings and Structures

## SCREEN MANUFACTURERS ASSOCIATION (SMA)

SMA 1004 (1987) Aluminum Tubular Frame Screens for Windows

## 1.2 WINDOW PERFORMANCE

Aluminum windows shall be designed to meet the following performance requirements. Testing requirements shall be performed by an independent testing laboratory or agency.

### 1.2.1 Structural Performance

Structural test pressures on window units shall be for positive load (inward) and negative load (outward) in accordance with ASTM E 330. After testing, there shall be no glass breakage, permanent damage to fasteners, hardware parts, support arms or actuating mechanisms or any other damage which could cause window to be inoperable. There shall be no permanent deformation of any main frame, sash or ventilator member in excess of the requirements established by AAMA 101 for the window types and classification specified in this section.

### 1.2.2 Air Infiltration

Air infiltration shall not exceed the amount established by AAMA 101 for each window type when tested in accordance with ASTM E 283.

### 1.2.3 Water Penetration

Water penetration shall not exceed the amount established by AAMA 101 for each window type when tested in accordance with ASTM E 547.

### 1.2.4 Thermal Performance

Thermal transmittance for thermally broken aluminum windows with insulating glass shall not exceed R-Value Class 0.44 m k/Q when tested in accordance with AAMA 1503.1.

### 1.2.5 Life Safety Criteria

Windows shall conform to NFPA 101 Life Safety Code when rescue and/or second means of escape are indicated.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

#### SD-01 Data

Aluminum Windows; FIO.

Manufacturer's descriptive data and catalog cut sheets.

#### SD-04 Drawings

Aluminum Windows; GA. Insect Screens; FIO.

Drawings indicating elevations of window, rough-opening dimensions for each type and size of window, full-size sections, thicknesses of metal, fastenings, methods of installation and anchorage, connections with other work, type of wall construction, size and spacing of anchors, method of glazing, types and locations of operating hardware, mullion details, weatherstripping details, [screen details including method of attachment,] [window cleaner anchor details], and window schedules showing locations of each window type.

#### SD-06 Instructions

Aluminum Windows; FIO.

Manufacturer's preprinted installation instructions and cleaning instructions.

#### SD-09 Reports

Aluminum Windows; FIO.

Reports for each type of aluminum window attesting that identical windows have been tested and meet all performance requirements established under paragraph WINDOW PERFORMANCE.

#### SD-13 Certificates

Aluminum Windows; FIO.

Certificates stating that the aluminum windows are AAMA certified conforming to requirements of this section. Labels or markings permanently affixed to the window will be accepted in lieu of certificates.

#### SD-14 Samples

Aluminum Windows; GA.

Manufacturer's standard color samples of the specified finishes and demonstration of durability and operation.

### 1.4 QUALIFICATION

Window manufacturer shall specialize in designing and manufacturing the type of aluminum windows specified in this section, and shall have a minimum of 5 years of documented successful experience. Manufacturer shall have the facilities capable of meeting contract requirements, single-source responsibility and warranty.

### 1.5 MOCK-UPS

Before fabrication, full-size mock-up of each type of aluminum window unit complete with glass and AAMA certification label shall be required for review of window construction and quality of hardware operation.

## 1.6 DELIVERY AND STORAGE

Aluminum windows shall be delivered to project site and stored in accordance with manufacturer's recommendations. Damaged windows shall be replaced with new windows.

## 1.7 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period shall be provided.

## 2 PRODUCTS

### 2.1 ALUMINUM WINDOW TYPES

Aluminum windows shall consist of complete units including sash, glass, frame, weatherstripping, and hardware. Windows shall conform to AAMA 101. Windows shall be double-glazed and shall have a minimum condensation resistance factor of 50 when tested in accordance with AAMA 1503.1. Operable windows shall permit cleaning the outside glass from inside the building.

#### 2.1.1 Double-Hung Windows

Aluminum double-hung windows shall conform to AAMA 101 DH-HC30 type which operate vertically with the weight of sash offset by a counterbalancing mechanism mounted in window to hold the sash stationary at any open position. Windows shall be provided with a tilt-in sash. Double-hung windows shall be provided with devices to secure the sash in the closed position. Counterbalancing mechanisms shall be easily replaced after installation.

#### 2.1.2 Fixed Windows

Aluminum fixed windows shall conform to AAMA 101 HS-HC30 type, non-operable glazed frame, complete with provisions for reglazing in the field.

#### 2.1.3 Projected Windows

Aluminum projected windows shall conform to AAMA 101 Designation P-C30 type or better and shall project-in type (at bottom).

### 2.2 WEATHERSTRIPPING

Weatherstripping for ventilating sections shall be of type designed to meet water penetration and air infiltration requirements specified in this section in accordance with AAMA 101, and shall be manufactured of material compatible with aluminum and resistant to weather. Weatherstrips shall be factory-applied and easily replaced in the field. Neoprene or polyvinylchloride weatherstripping are not acceptable where exposed to direct sunlight.

### 2.3 INSECT SCREENS

Insect screens shall be aluminum window manufacturer's standard design, and shall be provided for all operable windows, except projected type. Insect screens shall be fabricated of roll-formed tubular-shaped aluminum frames

conforming to SMA 1004 and (18 x 16) aluminum mesh screening conforming with ISWA IWS 089, Type III.

## 2.4 ACCESSORIES

### 2.4.1 Fasteners

Fastening devices shall be window manufacturer's standard design made from aluminum, non-magnetic stainless steel, cadmium-plated steel, nickel/chrome-plated steel or magnetic stainless steel in compliance with AAMA 101. Self-tapping sheet metal screws will not be acceptable for material thicker than 2 mm.

### 2.4.2 Hardware

Hardware shall be as specified for each window type and shall be fabricated of aluminum, stainless steel, cadmium-plated steel, zinc-plated steel or nickel/chrome-plated steel of quality established by AAMA 101.

### 2.4.3 Window Anchors

Anchoring devices for installing windows shall be made of aluminum, cadmium-plated steel, stainless steel, or zinc-plated steel conforming to AAMA 101.

## 2.5 GLASS AND GLAZING

Aluminum windows shall be designed for inside glazing, field glazing, and for glass types scheduled on drawings and specified in Section 08810 - GLASS AND GLAZING. Units shall be complete with glass and glazing provisions to meet AAMA 101. Glazing material shall be compatible with aluminum, and shall not require painting.

## 2.6 FINISH

### 2.6.1 Anodized Aluminum Finish

Exposed surfaces of aluminum windows shall be finished with anodic coating conforming to AA DAF-45: Architectural Class I, AA-M10-C22-A44, color anodic coating, 0.02 mm or thicker. Finish shall be free of scratches and other blemishes.

### 2.6.2 Color

Color shall be in accordance with Section 09915 - COLOR SCHEDULE.

## 3 EXECUTION

### 3.1 INSTALLATION

Aluminum windows shall be installed in accordance with approved shop drawings and manufacturer's published instructions. Aluminum surfaces in contact with masonry, concrete, wood and dissimilar metals other than stainless steel, zinc, cadmium or small areas of white bronze, shall be protected from direct contact using protective materials recommended by AAMA 101. The completed window installation shall be watertight in accordance with Section 07900 JOINT SEALING. Glass and glazing shall be installed in

accordance with requirements of this section and Section 08810 GLASS AND GLAZING.

### 3.2 ADJUSTMENTS AND CLEANING

#### 3.2.1 Hardware Adjustments

Final operating adjustments shall be made after glazing work is complete. Operating sash or ventilators shall operate smoothly and shall be weathertight when in locked position.

#### 3.2.2 Cleaning

Aluminum window finish and glass shall be cleaned on exterior and interior sides in accordance with window manufacturer's recommendations. Alkaline or abrasive agents shall not be used. Precautions shall be taken to avoid scratching or marring window finish and glass surfaces.



## SECTION 08700

## BUILDERS' HARDWARE

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 283	(1991) Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls and Doors Under Specified Pressure Differences Across the Specimen
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## BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

BHMA-01	(Effective thru Jun 1995) Directory of Certified Locks & Latches
BHMA-02	(Effective thru Jul 1995) Directory of Certified Door Closers
BHMA-03	(Effective thru Jul 1996) Directory of Certified Exit Devices
BHMA ANSI/BHMA A156.1	(1988) Butts and Hinges
BHMA ANSI/BHMA A156.2	(1989) Bored and Preassembled Locks and Latches
BHMA ANSI/BHMA A156.3	(1994) Exit Devices
BHMA ANSI/BHMA A156.4	(1992) Door Controls - Closers
BHMA ANSI/BHMA A156.5	(1992) Auxiliary Locks & Associated Products
BHMA ANSI/BHMA A156.6	(1994) Architectural Door Trim
BHMA ANSI/BHMA A156.7	(1988) Template Hinge Dimensions
BHMA ANSI/BHMA A156.8	(1994) Door Controls - Overhead Stops and Holders
BHMA ANSI/BHMA A156.13	(1994) Mortise Locks & Latches
BHMA ANSI/BHMA A156.16	(1989) Auxiliary Hardware
BHMA ANSI/BHMA A156.17	(1993) Self Closing Hinges & Pivots
BHMA ANSI/BHMA A156.18	(1993) Materials and Finishes
BHMA ANSI/BHMA A156.21	(1989) Thresholds

## DOOR AND HARDWARE INSTITUTE (DHI)

DHI-03	(1989) Keying Systems and Nomenclature
DHI-04	(1976) Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames
DHI-05	(1990) Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames
DHI-A115.IG	(1994) Installation Guide for Doors and Hardware
DHI A115-W	(Varies) Wood Door Hardware Standards (Incl A115-W1 thru A115-W9)

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80	(1995) Fire Doors and Windows
NFPA 101	(1997) Safety to Life from Fire in Buildings and Structures
NFPA 105	(1993) Installation of Smoke-Control Door Assemblies

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

## SD-01 Data

Hardware and Accessories; FIO.

Manufacturer's descriptive data, technical literature, catalog cuts, and installation instructions. Spare parts data for locksets, exit devices, closers, electric locks, electric strikes, electro-magnetic closer holder release devices, and electric exit devices, after approval of the detail drawings, and not later than 3 months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

## SD-04 Drawings

Hardware Devices; GA.

Detail drawings for hardware devices for computerized keying systems, magnetic cards, keyless push button access control systems, and other electrical hardware devices showing complete wiring and schematic diagrams and other details required to demonstrate proper function of units.

## SD-07 Schedules

## Hardware Schedule; GA.

Hardware schedule listing all items to be furnished. The schedule shall include for each item: the quantities; manufacturer's name and catalog numbers; the ANSI number specified, sizes; detail information or catalog cuts; finishes; door and frame size and materials; location and hardware set identification cross-references to drawings; corresponding reference standard type number or function number from manufacturer's catalog if not covered by ANSI or BHMA; and list of abbreviations and template numbers.

## Keying Schedule; GA.

Keying schedule developed in accordance with DHI-03, after the keying meeting with the user.

## SD-13 Certificates

## Hardware and Accessories; FIO.

The hardware manufacturer's certificates of compliance stating that the supplied material or hardware item meets specified requirements. Each certificate shall be signed by an official authorized to certify in behalf of the product manufacturer and shall identify quantity and date or dates of shipment or delivery to which the certificates apply. A statement that the proposed hardware items appear in BHMA-01, BHMA-02 and BHMA-03 directories of certified products may be submitted in lieu of certificates.

**Installer; GA.****Certification of installer.**

## 1.3 PREDELIVERY CONFERENCE

Upon approval of the Hardware Schedule, the construction Contractor shall arrange a conference with the hardware supplier, Contracting Officer and the using agency to determine keying system requirements. Location of the key control storage system, set-up and key identification labeling will also be determined.

## 1.4 DELIVERY, STORAGE, AND HANDLING

Hardware shall be delivered to the project site in the manufacturer's original packages. Each article of hardware shall be individually packaged in the manufacturer's standard commercial carton or container, and shall be properly marked or labeled to be readily identifiable with the approved hardware schedule. Each change key shall be tagged or otherwise identified with the door for which its cylinder is intended. Where double cylinder functions are used or where it is not obvious which is the key side of a door, appropriate instructions shall be included with the lock and on the hardware schedule. Manufacturer's printed installation instructions, fasteners, and special tools shall be included in each package.

### 1.5 SPECIAL TOOLS

Special tools, such as those supplied by the manufacturer, unique wrenches, and dogging keys, shall be provided as required to adjust hardware items.

### 1.6 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one year period shall be provided.

### 1.7 OPERATION AND MAINTENANCE MANUALS

Six complete copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides shall be provided. The instructions for electric locks, electric strikes, electro-magnetic closer holder release devices, and electric exit devices shall include simplified diagrams as installed.

### 1.8 INSTALLER

The installer shall have a minimum of 2 years experience and shall have been involved in installing at least 3 projects that are of comparable size, scope and complexity as this project for the particular hardware system furnished. The installer shall be trained and/or certified by the manufacturer to install the particular system specified. Training and certification shall be defined to include formal hands-on training given by the manufacturer in the installation of the specified hardware system. The training program shall have been in existence for not less than one year and shall include, but not be limited to the following: a specific course outline describing the goals of the training program and how those goals are met by the training; pertinent quality control methods of installation; and means of correcting work not meeting contract requirements.

## 2 PRODUCTS

### 2.1 GENERAL HARDWARE REQUIREMENTS

Hardware shall conform to the requirements specified herein and the HARDWARE SETS listing at the end of this section. Hardware set numbers correspond to the set numbers shown on the drawings.

### 2.2 TEMPLATES

Requirements for hardware to be mounted on metal doors or metal frames shall be coordinated between hardware manufacturer and door or frame manufacturer by use of templates and other information to establish location, reinforcement required, size of holes, and similar details. Templates of hinges shall conform to BHMA ANSI/BHMA A156.7.

### 2.3 HINGES

Hinges shall conform to BHMA ANSI/BHMA A156.1. Hinges used on metal doors and frames shall also conform to BHMA ANSI/BHMA A156.7. Except as otherwise specified, hinge sizes shall conform to the hinge manufacturer's printed recommendations.

### 2.3.1 Hinges for Reverse Bevel Doors with Locks

Hinges for reverse bevel doors with locks shall have pins that are made nonremovable by means such as a set screw in the barrel, or safety stud, when the door is in the closed position.

### 2.3.2 Contractor's Option

Hinges with antifriction bearings may be furnished in lieu of ball bearing hinges, except where prohibited for fire doors by the requirements of NFPA 80.

### 2.3.3 Pivot Hinges

Pivot hinges shall conform to BHMA ANSI/BHMA A156.4.

### 2.3.4 Spring Hinges

Spring hinges shall conform to BHMA ANSI/BHMA A156.17.

### 2.3.5 Electric Hinges

Electric hinges shall conform to BHMA ANSI/BHMA A156.1 with modification of added electric wires to insure correct operation of electric hardware items.

## 2.4 LOCKS AND LATCHES

To the maximum extent possible, locksets, latchsets and deadlocks shall be the products of a single manufacturer. Lock fronts for double-acting doors shall be rounded. Strikes for wood frames and pairs of wood doors shall be furnished with wrought boxes.

### 2.4.1 Bored Lock and Latchsets

Bored lock, latchsets, and strikes shall be series 4000 and shall conform to BHMA ANSI/BHMA A156.2, Grade 1. Bored type locks and latches for doors 35 mm thick and over shall have adjustable bevel fronts or otherwise conform to the shape of the door.

### 2.4.2 Electro-Mechanical Locks

Electro-mechanical locks shall allow for unlocking of doors from a remote location by means of push buttons. Locks shall be fail safe mode (unlocked when power is off). Locks shall be mortise series conforming to BHMA ANSI/BHMA A156.13 and bored series conforming to BHMA ANSI/BHMA A156.2 with factory installed electric lock modification or manufactured electro-mechanical locks conforming to BHMA ANSI/BHMA A156.13 or BHMA ANSI/BHMA A156.2 test standards.

### 2.4.3 Card Operated Lockset

Card operated locksets system shall be compatible with the M-6 lock and System 45 as manufactured by Sargent. Finish color shall be brown. The system shall be of mortise style and shall be a mechanical, stand-alone system that does not require wiring, batteries, or computer hookup. The system shall include keycards, staff keys, and cylinders.

Computerized key control system shall provide for documenting, issuing, and controlling keys of all types. System shall have the capability to store on the computer a complete description of all keyed items, including index numbers, location of openings, lock manufacture, key number, related master keys and grand master keys, total number of existing keys, and number of keys currently on loan. System shall include microcomputer, disk drive, compatible printer, and software package.

A Sargent M-6 data transfer unit model DTU 31-4 (or equivalent) shall be provided.

A Sargent M-6 interrogation unit or equivalent shall be provided.

A total of 5,000 plastic cards with magnetic strips shall be provided. Coercivity of magnetic strips shall be 600 or greater.

A tool kit with special system 45 PN: 45-5064-5400 tool for lock system shall be provided.

Extra locksets shall be provided to user in the amount of 10% for future maintenance use.

#### 2.4.4 Auxiliary Locks and Associated Products

Bored and mortise dead locks and dead latches, narrow style dead locks and dead latches, rim latches, dead latches, and dead bolts, and electric strikes shall conform to BHMA ANSI/BHMA A156.5. Bolt and latch retraction shall be dead bolt style. Strike boxes shall be furnished with dead bolt and latch strikes for Grade 1. Electric strikes shall be locked or unlocked from a remote location in fail safe mode. Electric strike for rated openings shall be fail secured.

#### 2.4.5 Lock Cylinders (Mortise, Rim and Bored)

Lock cylinders shall comply with BHMA ANSI/BHMA A156.5. Lock cylinder shall have not less than seven pins. Cylinders shall have key removable type cores equal to Best. A grand master keying system shall be provided. An extension of the existing keying system shall be provided. The cylinders shall be key compatible with existing locks within the previous project. Construction interchangeable cores shall be provided. Disassembly of knob or lockset shall not be required to remove core from lockset.

#### 2.4.6 Lock Trim

##### 2.4.6.1 Barracks

Lock trim shall be cast, forged, or heavy wrought construction of commercial plain design. In addition to meeting the test requirement of BHMA ANSI/BHMA A156.2 or BHMA ANSI/BHMA A156.13, knobs, roses, and escutcheons shall be 1.27 mm thick, if unreinforced. If reinforced, the outer shell shall be 0.89 mm thick and the combined thickness shall be 1.78 mm except that knob shanks shall be 1.52 mm thick. Knob diameter shall be 54 to 57 mm.

##### 2.4.6.2 Community Building

Lock trim shall be cast, forged, or heavy wrought construction of commercial plain design. In addition to meeting the test requirement of BHMA ANSI/BHMA

A156.2 or BHMA ANSI/BHMA A156.13, lever handles, roses, and escutcheons shall be 1.27 mm thick, if unreinforced. If reinforced, the outer shell shall be 0.89 mm thick and the combined thickness shall be 1.78 mm except that knob shanks shall be 1.52 mm thick. Lever handles shall be of plain design with ends returned to no more than 10 mm from the door face.

## 2.5 EXIT DEVICES AND EXIT DEVICE ACCESSORIES

Exit devices and exit device accessories shall conform to BHMA ANSI/BHMA A156.3, Grade 1.

### 2.5.1 Exit Devices and Auxiliary Items

Trim shall be of wrought construction and commercial plain design with straight, beveled, or smoothly rounded sides, corners, and edges. Adjustable strikes shall be provided for rim type and vertical rod devices. Open back strikes shall be provided for pairs of doors with mortise and vertical rod devices; except open back strikes shall be used on labeled doors only where specifically provided for in the published listings. Touch bars may be provided in lieu of conventional crossbars and arms, if matching previous project phase. Escutcheons shall be provided not less than 175 by 55 mm. Escutcheons shall be cut to suit cylinders and operating trim.

### 2.5.2 Door Coordinator

Door coordinator with carry bar shall be Type 21 and shall be provided for each pair of doors equipped with an overlapping astragal. The coordinator may be gravity operated and shall be capable of holding the active door of a pair open until the inactive door has preceded it in the closing cycle. When used as fire exit hardware, the coordinator and carry bar shall be listed or labeled by a nationally recognized independent testing laboratory.

### 2.5.3 Removable Mullions

Removable mullions shall be Type 22 of the box type and shall be used only with those exit devices for which the mullions were manufactured. Mullions shall be furnished with mullion stabilizers of the same manufacturer.

### 2.5.4 Electric Exit Devices

Electric exit devices shall conform to BHMA ANSI/BHMA A156.3 with factory installed electric lock modification having the capability to unlock from remote location by means of push button. Exit devices shall comply with life safety requirements of NFPA 101.

### 2.5.5 Automatic Flush Bolts

Automatic flush bolts shall be Type 25 in accordance with BHMA ANSI/BHMA A156.3, and shall be installed at the top and bottom of the inactive leaf of pairs of fire rated doors where specified in the hardware sets. Flush bolts shall be mortised in the strike edge of the door.

## 2.6 KEYING

Locks shall be keyed in sets or subsets as scheduled. Locks shall be furnished with the manufacturer's standard construction key system. Change

keys for locks shall be stamped with change number and the inscription "U.S. Property - Do Not Duplicate." Keys shall be supplied as follows:

Locks:	3 change keys each lock.
Master keyed sets:	4 keys each set.
Grand master keys:	4 total.
Construction keys:	12 total.
Blank keys:	25 total.

The keys shall be furnished to the Contracting Officer arranged for key control system storage in sets or subsets as scheduled.

## 2.7 DOOR CLOSING DEVICES

Door closing devices shall conform to BHMA ANSI/BHMA A156.4, Grade 1. Closing devices shall be products of one manufacturer for each type specified. The opening resistance of closing devices shall not exceed 67 N applied at the latch stile or exceed 22 N where low opening resistance is scheduled.

### 2.7.1 Surface Type Closers

Surface type closers shall be Grade 1, Series C02000 Standard Cover with options PT-4H, Size 1 or 2 through Size 6, and PT-4D with back check position valve. Except as otherwise specified, sizes shall conform to the manufacturer's published recommendations. Closers for outswinging exterior doors shall have parallel arms or shall be top jamb mounted. Closers for doors close to a wall shall be of narrow projection so as not to strike the wall at the 90-degree open position.

## 2.8 DOOR CONTROLS - OVERHEAD HOLDERS

Door controls - overhead holders shall conform to BHMA ANSI/BHMA A156.8.

## 2.9 ARCHITECTURAL DOOR TRIM

Architectural door trim shall conform to BHMA ANSI/BHMA A156.6.

### 2.9.1 Door Protection Plates

#### 2.9.1.1 Kick Plates

Kick plates shall be Type J106 plastic, bronze or brown in color, unless noted otherwise. Width of plates shall be 50 mm less than door width for single doors and 25 mm less for pairs of doors. Height shall be 300 mm, except where the bottom rail is less than 300 mm the plate shall extend to within 13 mm of the panel mold or glass bead. Stainless steel type shall have bevel edges.

#### 2.9.1.2 Mop Plates

Mop plates shall be Type J107 plastic, bronze or brown in color. Width of plates shall be 50 mm less than door width for single doors and 25 mm less for pairs of doors. The height shall be 100 mm.



## 2.9.2 Push Plates

### 2.9.2.1 Combination Push-Pull Plates

Combination push-pull plates shall be Type J303, 1.27 mm thick minimum stainless steel beveled four edges.

## 2.9.3 Door Pulls and Push/Pull Units

### 2.9.3.1 Arm Pulls

Arm pulls shall be Category J400, double base, stainless steel.

### 2.9.3.2 Door Pulls

Door pulls shall be Category J400 stainless steel] of plain modern design. Pulls for hollow metal, mineral core wood or kalamein doors shall be Type J405 thru-bolted to Type J301 flat push plates.

## 2.9.4 Push and Pull Bars

Push and pull bars shall be Category J500, stainless steel. Edges of mounting plates shall be beveled].

## 2.10 AUXILIARY HARDWARE

Auxiliary hardware, consisting of door holders, door stops, and roller latches, shall conform to BHMA ANSI/BHMA A156.16. Lever extension flush bolts shall be Type L14081. Dust-proof strikes shall be Type L04011 for doors that are not fire rated. Dust-proof strikes shall be Type L04021 for fire rated doors. Other auxiliary hardware of the types listed herein, shall conform to BHMA ANSI/BHMA A156.16.

## 2.11 MISCELLANEOUS

### 2.11.1 Automatic Door Bottoms

Automatic door bottoms shall be surface type with aluminum housing cover, anodized clear finish. Door bottom shall have a wool, felt, rubber, vinyl, or neoprene seal and shall be actuated by the opening and closing of the door. The door bottom shall exclude light when the door is in the closed position and shall inhibit the flow of air through the unit.

### 2.11.2 Metal Thresholds

Thresholds shall conform to BHMA ANSI/BHMA A156.21. Thresholds for exterior doors shall be extruded aluminum of the type indicated and shall provide proper clearance and an effective seal with specified weather stripping. Latching thresholds shall conform to BHMA ANSI/BHMA A156.3, Type 26, and of such height that the bottom of the door shall be 3 mm over the tread of the threshold and 3 mm below the top of the stop. Where required, thresholds shall be modified to receive projecting bolts of flush bolts or exit devices. Thresholds for doors accessible to the handicapped shall be beveled with slopes not exceeding 1:2 and with heights not exceeding 13 mm. Air leakage rate of weatherstripping shall not exceed 0.775 liters per second per lineal meter of crack when tested in accordance with ASTM E 283 at standard test conditions.

### 2.11.3 Rain Drips

Extruded aluminum, not less than 1.78 mm thick, anodized as selected. Door sill rain drips shall be 38 mm to 44 mm high by 16 mm projection. Overhead rain drips shall be approximately 38 mm high by 63 mm projection and shall extend 50 mm on either side of the door opening width.

#### 2.11.3.1 Acceptable Manufacturer

Door drips shall be the following: Pemko 346D or approved equal, unless otherwise noted. Finish shall be bronze anodized, unless otherwise noted.

### 2.11.4 Aluminum Housed Type Weatherseals

Weatherseals of the type indicated shall consist of extruded aluminum retainers not less than 1.78 mm wall thickness with vinyl, neoprene, silicone rubber, polyurethane or vinyl brush inserts. Aluminum shall be clear (natural) anodized. Weatherseal material shall be of an industrial/commercial grade. Seals shall remain functional through all weather and temperature conditions. Air leakage rate of weatherstripping shall not exceed 0.775 liters per second per lineal meter of crack when tested in accordance with ASTM E 283 at standard test conditions.

#### 2.11.4.1 Acceptable Manufacturer

Weatherseals shall be Pemko 296DR (bronze anodized with sponge neoprene insert) or approved equal.

### 2.11.5 Key Control Storage System

Key control storage system shall conform to BHMA ANSI/BHMA A156.5, Type E8351, capacity 150, and shall be properly labeled for key identification. Set up, identification labeling and location of the key control storage shall be as directed at the Predelivery Conference.

## 2.12 FASTENINGS

Fastenings of proper type, size, quantity, and finish shall be supplied with each article of hardware. Machine screws and expansion shields shall be used for attaching hardware to concrete or masonry. Fastenings exposed to the weather in the finished work shall be of brass, bronze, or stainless steel. Sex bolts, through bolts, or machine screws and grommet nuts, where used on reverse-bevel exterior doors equipped with half-surface or full-surface hinges, shall employ one-way screws or other approved tamperproof screws. Screws for the jamb leaf of half-mortise and full-surface hinges attached to structural steel frames shall be one-way or other approved tamperproof type.

## 2.13 FINISHES

Unless otherwise specified, finishes shall conform to those identified in BHMA ANSI/BHMA A156.18. Where painting of primed surfaces is required, painting is specified in Section 09900 PAINTING, GENERAL.

### 2.13.1 Hinges

Hinges shall have the following finishes:

- a. Exterior aluminum and hollow metal doors: 630 (satin stainless)
- b. Interior doors within Barracks: 638 (satin brass plated, blackened-'antique brass')
- c. Interior doors within Community Building: 641 (oxidized satin bronze plated, relieved, clear coated)

### 2.13.2 Lock and Door Trim

Lock and door trim shall have the following finishes:

- a. Exterior aluminum and hollow metal doors: 630 (satin stainless)
- b. Interior doors within Barracks: 638 (satin brass plated, blackened-'antique brass')
- c. Interior doors within Community Building: 641 (oxidized satin bronze plated, relieved, clear coated)

### 2.13.3 Door Closers

Door closer finish shall be dark bronze.

### 2.13.4 Miscellaneous Hardware

Miscellaneous hardware and exposed trim:

- a. Barracks-exterior: compatible with finish 630 (satin stainless).
- b. Barracks-interior: compatible with finish 638 (satin brass plated, blackened-antique brass), unless noted otherwise.
- c. Community Building-exterior: compatible with finish 630 (satin stainless).
- d. Community Building-interior: compatible with finish 644 (dark oxidized satin bronze plated)

## 2.14 HARDWARE FOR FIRE DOORS

Hardware for fire doors shall conform to the requirements of NFPA 80 and NFPA 101.

## 3 EXECUTION

### 3.1 APPLICATION

Hardware shall be located in accordance with DHI-04 and DHI-05, except that deadlocks shall be mounted 1220 mm above finish floor. When approved, slight variations in locations or dimensions will be permitted. Application shall be in accordance with DHI-A115.IG or DHI A115-W. Door control devices for exterior doors such as closers and holders, shall be attached to doors

with thru bolts and nuts or sex bolts. Alternate fastening methods may be approved by the Contracting Officer when manufacturers' documentation is submitted to verify that the fastening devices and door reinforcements are adequate to resist wind induced stresses. Electric hardware items and access control devices shall be installed in accordance with manufacturer's printed installation procedures.

#### 3.1.1 Hardware for Fire Doors and Smoke-Control Door Assemblies

Hardware for fire doors shall be installed in accordance with the requirements of NFPA 80. Exit devices installed on fire doors shall have a visible label bearing the marking "Fire Exit Hardware". Other hardware installed on fire doors, such as locksets, closers, and hinges shall have a visible label or stamp indicating that the hardware items have been approved by an approved testing agency for installation on fire-rated doors. Hardware for smoke-control door assemblies shall be installed in accordance with NFPA 105.

#### 3.1.2 Door-Closing Devices

Door-closing devices shall be installed and adjusted in accordance with the templates and printed instructions supplied by the manufacturer of the devices. Insofar as practicable, doors opening to or from halls and corridors shall have the closer mounted on the room side of the door.

#### 3.1.3 Key Control Storage Systems

Key control storage system shall be installed where directed by the Contracting Officer.

#### 3.1.4 Kick Plates and Mop Plates

Kick plates shall be installed on the push side of single-acting doors and on both sides of double-acting doors. Mop plates shall be installed on the pull side of the single acting doors.

#### 3.1.5 Auxiliary Hardware

Lever extension flush bolts shall be installed at the top and bottom of the inactive leaf of pairs of doors. The bottom bolt shall operate into a dust-proof floor strike or threshold.

#### 3.1.6 Thresholds

Thresholds shall be secured with a minimum of three fasteners per single door width and six fasteners per double door width with a maximum spacing of 300 mm. Exterior thresholds shall be installed in a bed of sealant with expansion anchors and stainless steel screws, except that bronze or anodized bronze thresholds shall be installed with expansion anchors with brass screws. Minimum screw size shall be No. 10 length, dependent on job conditions, with a minimum of 19 mm thread engagement into the floor or anchoring device used.

## 3.1.7 Rain Drips

Door sill rain drips shall align with the bottom edge of the door. Overhead rain drips shall align with bottom edge of door frame rabbet. Drips shall be set in sealant and fastened with stainless steel screws.

## 3.1.8 Weatherseals

Weatherseals shall be located as indicated, snug to door face and fastened in place with color matched metal screws after door and frames have been finish painted. Screw spacing shall be as recommended by manufacturer.

## 3.2 OPERATIONAL TESTS

Prior to acceptance of any electrical hardware system, an operational test shall be performed to determine if devices are operating as intended by the specifications. Wiring shall be tested for correct voltage, current carrying capacity, and proper grounding. Stray voltages in lock wiring shall be eliminated to prevent locking devices from releasing in critical situations.

## 3.3 HARDWARE SETS

## BARRACKS BUILDING

HW-B1	Door BARR1; Barracks Suite Entrance (single ext. alum. door/alum. frame)
1-1/2 pr.	Hinges, A5112 NRP
1 ea.	Lockset, F93 (Sargent M6 or equiv.)
1 ea.	Closer, C02021
1 ea.	Kick Plate, J106
1 ea.	Door Stop, L02252
1 ea.	Threshold, Pemko 182A
1 ea.	Door Shoe/Rain Drip, Pemko 216DPK
1 ea.	Door Viewer, L03171 (627 finish-mount @ 1 524 mm A.F.F.)
1 set	Weatherseals
HW-B2	Doors BARR2; Closet (single int. solid-core wood door/hollow metal frame)
1-1/2 pr.	Hinges, A1112
1 ea.	Passage Set, F75
1 ea.	Door Stop, L02252
HW-B3	Door BARR3; Service Area (single int. solid-core wood door/hollow metal frame)
1 1/2 pr	Hinges, A1112
1 ea.	Passage Set, F75
1 ea.	Door Stop, L02252
1 ea.	Deadbolt, E0191 (Thumb turn on bedroom side)
	Both open & locked positions shall require manual movement of the lock without any automatic operation of the lock.

HW-B4 Door BARR5; Bath (single int. solid-core wood door/hollow metal frame)

1 1/2 pr. Hinges, A1112  
1 ea. Latchset, F76 (push button on bathroom side)  
1 ea. Door Stop, L02252

HW-B5 Door BARR6, Electrical (single ext. hollow metal door/frame)

1-1/2 Pr. Hinges, A5112 NRP  
1 ea. Lockset, F86  
1 ea. Door Stop, L02252  
1 ea. Door Shoe/Rain Drip, Pemko 182A  
1 ea. Threshold, Pemko 277AR  
1 set Weatherseals

HW-B6 Doors BARR7, Mechanical (pair ext. hollow metal door/frame)

3 pr. Hinges, A5112 NRP  
1 ea. Lockset, F86  
1 ea. Door Stop, L02252  
2 ea. Manual Flush Bolt, L04081  
2 ea. Dustproof Strike, L04021  
1 ea. Door Shoe/Rain Drip, Pemko 216DPK  
1 ea. Threshold, Pemko 182A  
1 set Weatherseals

HW-B7 Door BARR8, Mud Room (single ext. hollow metal door/frame)

1-1/2 pr. Hinges, A5112  
1 ea. Lockset, F93 (Sargent M6 or equiv.)  
1 ea. Closer, C02021  
1 ea. Mop/Kick Plate, J106 (outside)  
1 ea. Door Stop, L02252  
1 ea. Door Shoe/Rain Drip, Pemko 216DPK  
1 ea. Threshold, Pemko 182A  
1 set Weatherseals

HW-B8 Door BARR9, Maid (single int. hollow metal door/frame)

1-1/2 pr. Hinges, A5112  
1 ea. Lockset, F86  
1 ea. Closer, C02021  
1 ea. Mop plate, J106  
1 ea. Door Stop, L02252

HW-B9 Door ACC-1, Crawlspace access door (single ext. hollow Metal door/frame)

1 pr. Hinges, A5112  
1 ea. Lockset, F86  
1 set Weatherseals

## COMMUNITY BUILDING

HW-C1 Door 4-101; South Entrance (pair ext. alum. w/ exit device)

- 3 pr. Hinges, A5112 NRP
- 2 ea. Closer, C02021
- 2 ea. Exit Device, Type 23, Function 08 (lever on outside)
- 1 ea. Lockset, F93 (Sargent M6 or equiv., with levers)
- 4 ea. Dust-Proof Strike, L04021
- 1 ea. Astragal (adj. type), Pemko 351DP (pile/brush)
- 2 ea. Door Stop, L02161
- 2 ea. Door Shoe/Rain Drip, Pemko 216DPK
- 1 ea. Threshold, Pemko 182A
- 1 set Weatherseals

HW-C2 Doors 4-102/4-103, Restroom (single int. solid-core wood/H.M. frame with push/pull function)

- 1-1/2 pr. Hinges, A8112
- 1 ea. Closer, C02061 (HO)
- 1 ea. Push Plate, J304 (stainless)
- 1 ea. Pull Plate, J407 (stainless)
- 1 ea. Mop Plate, J107 (outside)
- 1 ea. Door Stop, L02141

**HW-C3 Doors 4-107/4-119, North Entrance (single ext. alum. door)**

- 1-1/2 pr. Hinges, A5112
- 1 ea. Closer, C02021
- 1 ea. Lockset, F93 (Sargent M6 or equiv., with levers)
- 1 ea. Door Stop, L02161
- 1 ea. Door Shoe/Rain Drip, Pemko 216DPK
- 1 ea. Threshold, Pemko 182A
- 1 set Weatherseals

**HW-C4 Door 4-106/4-110, Activity, Laundry (single int. SC wood/H.M. frame)**

- 1-1/2 pr. Hinges, A2112
- 1 ea. Closer, C02021
- 1 ea. Passage Set, F75 (with levers)
- 1 ea. Kick Plate, J106
- 1 ea. Door Stop, L02141

**HW-C5 Door 4-104, North Entrance (single ext. alum. door w/ exit device)**

- 1-1/2 pr. Hinges, A5112
- 1 ea. Closer, C02021
- 1 ea. Exit Device, Type 23, Function 08 (lever on outside)
- 1 ea. Lockset, F93 (Sargent M6 or equiv., with levers)
- 1 ea. Astragal (adj. Type), Pemko 351DP (pile/brush)
- 1 ea. Door Stop, L02161
- 1 ea. Door Shoe/Rain Drip, Pemko 216DPK
- 1 ea. Threshold, Pemko 182A

	1 set	Weatherseals
<b><u>HW-C6</u></b>	<b><u>not used</u></b>	
<b><u>HW-C7</u></b>	<b><u>not used</u></b>	
<b><u>HW-C8</u></b>	<b><u>Doors 4-109/4-112, Janitor/Dryer Chase (single int. SC wood/H.M. frame)</u></b>	
	1-1/2 pr.	Hinges, A8112 NRP
	1 ea.	Deadlock, F82 (entry lock with levers)
	1 ea.	Mop plate, J107 (4-109 only)
	1 ea.	Door Stop, L02141
HW-C9	Doors 4-112/4-113, Mech. (pair ext. hollow metal door/frame)	
	3 pr.	Hinges, A5112 NRP
	1 ea.	Deadlock, F86 (with levers)
	2 ea.	Manual Flush Bolt, L04081
	2 ea.	Dustproof Strike, L04021
	1 ea.	Astragal (adjustable), Pemko 351DP (pile/brush)
	2 ea.	Kick Plate, J106
	2 ea.	Door Stop, L02161
	1 ea.	Rain Drip (@ bottom)
	1 ea.	Rain Drip (@ top)
	1 ea.	Threshold, Pemko 277AR
	1 set	Weatherseals
HW-C10	Gates 4-114/4-115, mech. courtyard gates (pair ext. gates)	
	3 pr.	Heavy-duty galv. Hinges
	2 ea.	Heavy-duty galv. Hasps
	1 ea.	Cane Bolt (galv.), 25 mm diam. X 1 000 mm high
HW-C11	4-117/4-118, Tele./Elec. (single ext. H.M. door/frame)	
	1-1/2 pr.	Hinges, A5112 NRP
	1 ea.	Lockset, F86 (with levers)
	1 ea.	Door Stop, L02161
	1 ea.	Rain Drip (@ bottom)
	1 ea.	Threshold, Pemko 277AR
	1 set	Weatherseals
<b><u>HW-C12</u></b>	<b><u>Doors 4-111, 4-120, 4-121, 4-122; Bulk Stor. (single ext. hollow metal door/frame)</u></b>	
	1-1/2 pr.	Hinges, A5112 NRP
	1 ea.	Lockset, F93 (Sargent M6 or equiv., with levers)
	1 ea.	Kick Plate, J102 (stainless)
	1 ea.	Door Stop, L02161
	1 ea.	Door Shoe/Rain Drip, Pemko 216DPK
	1 ea.	Threshold, Pemko 182A
	1 set	Weatherseals



## SECTION 08810

## GLASS AND GLAZING

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z97.1 (1984; R 1994) Safety Performance Specifications and Methods of Test for Safety Glazing Materials Used in Buildings

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 509 (1994) Elastomeric Cellular Preformed Gasket and Sealing Material

ASTM C 669 (1995) Glazing Compounds for Back Bedding and Face Glazing of Metal Sash

ASTM C 864 (1993) Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers

ASTM C 920 (1995) Elastomeric Joint Sealants

ASTM C 1036 (1991) Flat Glass

ASTM C 1048 (1992) Heat-Treated Flat Glass - Kind HS, Kind FT Coated and Uncoated Glass

ASTM D 395 (1989; R 1994) Rubber Property - Compression Set

ASTM E 773 (1988) Seal Durability of Sealed Insulating Glass Units

ASTM E 774 (1992) Sealed Insulating Glass Units

ASTM E 1300 (1994) Determining the Minimum Thickness and Type of Glass Required to Resist a Specified Load

## COMMERCIAL ITEM DESCRIPTION (CID)

CID A-A-378 (Basic) Putty Linseed Oil Type, (for Wood-Sash-Glazing)

## GLASS ASSOCIATION OF NORTH AMERICA (GANA)

GANA-01 (1997) Glazing Manual

GANA-04 (1995) Engineering Standards Manual

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80

(1995) Fire Doors and Fire Windows

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

## SD-01 Data

Glass; FIO.

Glazing Accessories; FIO.

Manufacturer's descriptive product data, handling and storage recommendations, installation instructions, and cleaning instructions.

## SD-04 Drawings

Glazing Materials and Accessories; FIO.

Drawings showing complete details of the proposed setting methods, mullion details, edge blocking, size of openings, frame details, materials, and types and thickness of glass.

## SD-13 Certificates

Glass; FIO.

Certificates stating that the glass meets the specified requirements. Labels or manufacturers marking affixed to the glass will be accepted in lieu of certificates.

## SD-14 Samples

Glass; FIO.

Two 203 x 254 mm samples of each of the following: tinted glass, patterned glass, and insulating glass units.

## 1.3 SYSTEM DESCRIPTION

Glazing systems shall be fabricated and installed watertight and airtight to withstand thermal movement and wind loading without glass breakage, gasket failure, deterioration of glazing accessories, and defects in the work. Glazed panels shall comply with the safety standards, as indicated in accordance with ANSI Z97.1. Glazed panels shall comply with indicated wind/snow loading in accordance with ASTM E 1300.

## 1.4 DELIVERY, STORAGE AND HANDLING

Glazing compounds shall be delivered to the site in the manufacturer's unopened containers. Glass shall be stored indoors in a safe, well ventilated dry location in accordance with manufacturer's instructions, and

shall not be unpacked until needed for installation. Glass shall not be stored on site over 1 month.

## 1.5 PROJECT/SITE CONDITIONS

Glazing work shall not be started until outdoor temperature is above 5 degrees C and rising, unless procedures recommended by glass manufacturer and approved by Contracting Officer are made to warm the glass and rabbet surfaces. Ventilation shall be provided to prevent condensation of moisture on glazing work during installation. Glazing work shall not be performed during damp or raining weather.

## 1.6 WARRANTY

### 1.6.1 Insulating Glass

Manufacturer shall warrant the insulating glass to be free of fogging or film formation on the internal glass surfaces caused by failure of the hermetic seal for a period of 10 years from Date of Substantial Completion. Warranty shall be signed by manufacturer.

## 2 PRODUCTS

### 2.1 FLOAT GLASS

#### 2.1.1 Annealed Glass

Annealed glass shall be Type I transparent flat type, Class 1 - Quality q3 - glazing select, minimum 85 percent light transmittance, minimum 0.95 shading coefficient, conforming to ASTM C 1036. Color shall be as shown in Section 09915 COLOR SCHEDULE.

#### 2.1.2 Tinted (Light-Reducing) Glass

Tinted (light-reducing) glass shall be Type I transparent flat type, Class 3-tinted, Quality q3 - glazing select, maximum 52 percent light transmittance, maximum 0.70 percent shading coefficient, conforming to ASTM C 1036. Color shall be as shown in Section 09915 COLOR SCHEDULE.

### 2.2 ROLLED GLASS

#### 2.2.1 Patterned Glass

Patterned glass shall be Type II flat type. Class 1 - 3 mm tempered float glass, patterned with interlayer, Quality q5, minimum 85 percent light transmittance, 0.95 percent shading coefficient, conforming to ASTM C 1036. Color shall be as shown in Section 09915 COLOR SCHEDULE.

##### 2.2.1.1 Acceptable Manufacturer

Patterned glass shall be 'ChromaFusion Architectural Graphic Glass' as manufactured by Cesar Color Inc., (800) 275-7272, or approved equal.

### 2.3 INSULATING GLASS

Insulating glass shall be Class A preassembled units of dual-seal construction consisting of lites of glass separated by an aluminum, steel,

or stainless steel, spacer and dehydrated space conforming to ASTM E 773 and ASTM E 774. Spacer shall be roll-formed, with bent or tightly welded or keyed and sealed joints to completely seal the spacer periphery and eliminate moisture and hydrocarbon vapor transmission into airspace through the corners. Primary seal shall be compressed polyisobutylene and the secondary seal shall be a specially formulated silicone. Glass types shall be as follows:

#### 2.3.1 Clear Insulating Glass

Glass for two-pane insulating units shall be Type I annealed glass, Class 1 - clear on inside pane, Class 2 -tinted on outside pane, Quality q3 - glazing select, conforming to ASTM C 1036. Glass performance shall be K-Value/Winter Nighttime 2.8 W/sq. meter/degree C.

#### 2.4 HEAT-TREATED GLASS

Heat-treated glass shall conform to the following requirements.

##### 2.4.1 Tempered Glass

Tempered glass shall be kind FT fully tempered transparent flat type, Class 1-clear, Condition A uncoated surface, Quality q3 - glazing select, 85 percent light transmittance, 0.95 percent shading coefficient conforming to ASTM C 1048 and GANA-04. Color shall be as shown in Section 09915 COLOR SCHEDULE.

#### 2.5 MIRRORS

##### 2.5.1 Glass Mirrors

Glass for mirrors shall be Type I transparent flat type, Class 1-clear, Glazing Quality q1 6 mm thick conforming to ASTM C 1036. Glass color shall be clear. Glass shall be coated on one surface with silver coating, copper protective coating, and mirror backing paint. Silver coating shall be highly adhesive pure silver coating of a thickness which shall provide reflectivity of 83 percent or more of incident light when viewed through 6 mm thick glass, and shall be free of pinholes or other defects. Copper protective coating shall be pure bright reflective copper, homogeneous without sludge, pinholes or other defects, and shall be of proper thickness to prevent "adhesion pull" by mirror backing paint. Mirror backing paint shall consist of two coats of special scratch and abrasion-resistant paint, and shall be baked in uniform thickness to provide a protection for silver and copper coatings which will permit normal cutting and edge fabrication.

##### 2.5.2 Mirror Accessories

###### 2.5.2.1 Mastic

Mastic for setting mirrors shall be a polymer type mirror mastic resistant to water, shock, cracking, vibration and thermal expansion. Mastic shall be compatible with mirror backing paint, and shall be approved by mirror manufacturer.

#### 2.5.2.2 Mirror Frames

Mirrors shall be provided with mirror frames (J-mold channels) fabricated of one-piece roll-formed Type 304 stainless steel with No. 4 brushed satin finish and concealed fasteners which will keep mirrors snug to wall. Frames shall be 32 x 6 x 6 mm continuous at top and bottom of mirrors. Concealed fasteners of type to suit wall construction material shall be provided with mirror frames.

#### 2.5.2.3 Mirror Clips

Concealed fasteners of type to suit wall construction material shall be provided with clips.

### 2.6 GLAZING ACCESSORIES

#### 2.6.1 Preformed Tape

Preformed tape shall be elastomeric rubber extruded into a ribbon of a width and thickness suitable for specific application. Tape shall be of type which will remain resilient, have excellent adhesion, and be chemically compatible to glass, metal, or wood.

#### 2.6.2 Sealant

Sealant shall be elastomeric conforming to ASTM C 920, Type S or M, Grade NS, Class 12.5, Use G, of type chemically compatible with setting blocks, preformed sealing tape and sealants used in manufacturing insulating glass. Color of sealant shall be as selected.

#### 2.6.3 Glazing Gaskets

Glazing gaskets shall be extruded with continuous integral locking projection designed to engage into metal glass holding members to provide a watertight seal during dynamic loading, building movements and thermal movements. Glazing gaskets for a single glazed opening shall be continuous one-piece units with factory-fabricated injection-molded corners free of flashing and burrs. Glazing gaskets shall be in lengths or units recommended by manufacturer to ensure against pull-back at corners. Glazing gasket profiles shall be as indicated on drawings.

##### 2.6.3.1 Fixed Glazing Gaskets

Fixed glazing gaskets shall be closed-cell (sponge) smooth extruded compression gaskets of cured elastomeric virgin neoprene compounds conforming to ASTM C 509, Type 2, Option 1.

##### 2.6.3.2 Wedge Glazing Gaskets

Wedge glazing gaskets shall be high-quality extrusions of cured elastomeric virgin neoprene compounds, ozone resistant, conforming to ASTM C 864, Option 1, Shore A durometer between 65 and 75.

##### 2.6.3.3 Aluminum Framing Glazing Gaskets

Glazing gaskets for aluminum framing shall be permanent, elastic, non-shrinking, non-migrating, watertight and weathertight.

#### 2.6.4 Putty and Glazing Compound

Glazing compound shall conform to ASTM C 669 for face-glazing metal sash. Putty shall be linseed oil type conforming to CID A-A-378 for face-glazing primed wood sash. Putty and glazing compounds shall not be used with insulating glass or laminated glass.

#### 2.6.5 Setting and Edge Blocking

Neoprene setting blocks shall be dense extruded type conforming to ASTM D 395, Method B, Shore A durometer between 70 and 90. Edge blocking shall be Shore A durometer of 50 (+ or - 5). Silicone setting blocks shall be required when blocks are in contact with silicone sealant. Profiles, lengths and locations shall be as required and recommended in writing by glass manufacturer.

### 3 EXECUTION

#### 3.1 PREPARATION

Openings and framing systems scheduled to receive glass shall be examined for compliance with approved shop drawings, GANA-01 and glass manufacturer's recommendations including size, squareness, offsets at corners, presence and function of weep system, face and edge clearance requirements and effective sealing between joints of glass-framing members. Detrimental materials shall be removed from glazing rabbet and glass surfaces and wiped dry with solvent. Glazing surfaces shall be dry and free of frost.

#### 3.2 INSTALLATION

Glass and glazing work shall be performed in accordance with approved shop drawings, GANA-01, glass manufacturer's instructions and warranty requirements. Glass shall be installed with factory labels intact and removed only when instructed. Wired glass and fire/safety rated glass shall be installed in accordance with NFPA 80. Edges and corners shall not be ground, nipped or cut after leaving factory. Springing, forcing or twisting of units during installation will not be permitted.

#### 3.3 CLEANING

Upon completion of project, outside surfaces of glass shall be washed clean and the inside surfaces of glass shall be washed and polished in accordance with glass manufacturer's recommendations.

#### 3.4 PROTECTION

Glass work shall be protected immediately after installation. Glazed openings shall be identified with suitable warning tapes, cloth or paper flags, attached with non-staining adhesives. Reflective glass shall be protected with a protective material to eliminate any contamination of the reflective coating. Protective material shall be placed far enough away from the coated glass to allow air to circulate to reduce heat buildup and moisture accumulation on the glass. Glass units which are broken, chipped, cracked, abraded, or otherwise damaged during construction activities shall be removed and replaced with new units.

## SECTION 08920

## GLAZED ALUMINUM CURTAIN WALL SYSTEM

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## ALUMINUM ASSOCIATION (AA)

Designation System for Aluminum Finishes.

## AMERICAN ARCHITECTURAL MANUFACTURERS' ASSOCIATION (AAMA)

Curtain Wall, Window, Store Front and  
Entrance - Guide Specifications Manual

Aluminum Curtain Wall Design Guide Manual

## CURTAIN WALL MANUAL #10

Care and Handling of Architectural Aluminum  
From Shop to Site

## SERIES NO. 11

Design Wind Loads for Buildings and Boundary  
Layer Wind Tunnel Testing

## 501.2

Methods of Test for Metal Curtain Walls

## 603.8

Performance Requirements and Test Procedures  
for Pigmented Organic Coatings on Extruded  
Aluminum

## 605.2

Specification for High Performance Organic  
Coatings on Architectural Extrusions and  
Panels

## 606.1

Specifications and Inspection Methods for  
Integral Color Anodic Finishes for  
Architectural Aluminum

## 607.1

Specifications and Inspection Methods for  
Clear Anodic Finishes for Architectural  
Aluminum

## 608.1

Specification and Inspection Methods for  
Electrolytically Deposited Color Anodic  
Finishes for Architectural Aluminum

## 1502.7

Test Method for Condensation Resistance of  
Windows, Doors, and Glazed Wall Sections

## TIR-A1

Sound Control for Aluminum Curtain Walls and  
Windows

FC-1                      Field Check of Metal Curtain Walls for Water Leakage

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 788                      Calculation of Wind Loads

ASTM C 669                      (1995) Glazing Compounds for Back Bedding and Face Glazing of Metal Sash

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36/36M                      Structural Steel

ASTM A 123                      Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

ASTM A 446/446M                      Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality

ASTM B 209/209M                      Aluminum and Aluminum-Alloy Sheet and Plate

ASTM B 221/221M                      Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes

ASTM E 283                      Test Method for Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors

ASTM E 330                      Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.

ASTM E 331                      Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference

ASTM E 413                      Classification for Rating Sound Insulation

ASTM E 1105                      Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Curtain Walls, and Doors by Uniform or Cyclic Static Air Pressure Difference

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

PAINT 20                      Zinc Rich Coating

PAINT 25                      Red Iron Oxide, Zinc Oxide, Raw Linseed Oil and Alkyd Primer (Without Lead and Chromate Pigments)



## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

### SD-01 Data

Glazed Aluminum Curtainwall System; FIO.

Product Data: Provide manufacturer's specifications, standard details, and installation requirements.

### SD-04 Drawings

Glazed Aluminum Curtainwall System; GA.

Shop Drawings: Indicate framed opening requirements and tolerances, spacing of all members, anticipated deflection under load, affected related work, expansion and contraction joint locations and details, and sizes and locations for field welding.

### SD-06 Instructions

Glazed Aluminum Curtainwall System; FIO.

Manufacturer's preprinted installation instructions and cleaning instructions.

### SD-09 Reports

Glazed Aluminum Curtainwall System; FIO.

Test Reports: Submit substantiating engineering data, test results of previous testing of similar assemblies meeting performance criteria, and other supporting data.

### SD-13 Certificates

Glazed Aluminum Curtainwall System; FIO.

Certificates stating that the glazing systems are certified conforming to requirements of this section. Labels or markings permanently affixed to the window will be accepted in lieu of certificates.

### SD-14 Samples

Glazed Aluminum Curtainwall System; GA.

Manufacturer's standard color samples of the specified finishes.

Samples: Submit two samples, not less than 300 mm x 300 mm in size illustrating appearance of prefinished aluminum and specified glazing system, including glazed edge and corner.

### 1.3 SYSTEM DESCRIPTION AND REQUIREMENTS

Curtain Wall System: Tubular aluminum sections with self supporting framing, factory prefinished, vision glass; related flashings, anchorage and attachment devices.

System Assembly: Site assembled, or shop unitized assembly, as applicable.

System Design: Design and size components to withstand dead loads and live loads caused by positive and negative wind loads acting normal to plane of wall to a design pressure of 1.0 kPa positive and 2.5 kPa negative.

Seismic Loads: Design and size components to withstand seismic loads and sway displacement as calculated in accordance with UBC (latest edition).

Deflection: Limit mullion deflection to L/360 with full recovery of glazing materials.

System Assembly: Accommodate without damage to system, components or deterioration of seals, movement within system, movement between system and perimeter framing components, dynamic loading and release of loads, deflection of structural support framing, tolerance of supporting components.

Thermal Resistance of Wall System (Excluding Vision Areas): N/A.

Thermal Resistance of Vision Areas: N/A.

Water Leakage: None, when measured in accordance with ASTM E331.

Expansion / Contraction: System to provide for expansion and contraction within system components caused by a cycling temperature range of 56 degrees C over a 12 hour period without causing detrimental affect to system components.

System Internal Drainage: Drain water entering joints, condensation occurring in glazing channels, or migrating moisture occurring within system, to the exterior by a weep drainage network.

Not Permitted: Vibration harmonics, wind whistles, noises caused by thermal movement, thermal movement transmitted to other building elements, loosening, weakening, or fracturing of attachments or components of system.

### 1.4 QUALITY ASSURANCE

Perform Work in accordance with AAMA - Aluminum Curtain Wall Design Guide Manual. Maintain one copy on site.

Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience and approved by manufacturer.

Design structural support framing components under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed at the place where the Project is located.

#### 1.5 MOCKUP

Provide 1 200 x 1 500 mm wide mockup including intermediate mullion, corner mullion, sill muntin, and vision glass light. Assemble to illustrate component assembly including glazing materials, weep drainage system, attachments, anchors, and perimeter sealant.

Locate where directed.

Mockup may remain as part of the Work.

#### 1.6 PRE-INSTALLATION MEETING

Convene one week before starting work of this section.

#### 1.7 DELIVERY, STORAGE, AND PROTECTION

The work of this Section shall be performed in accordance with AAMA - Curtain Wall Manual #10.

Protect prefinished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings which bond when exposed to sunlight or weather. Puncture wrappings at ends for ventilation.

#### 1.8 ENVIRONMENTAL REQUIREMENTS

Do not install sealants when ambient temperature is less than that recommended by manufacturer.

Maintain this minimum temperature during and after installation of sealants.

#### 1.9 COORDINATION

Coordinate the Work with installation of firestopping, air barrier placement, vapor retarder placement, installing ductwork to rear of louvers, and other components or materials.

#### 1.10 WARRANTY

Provide a five year warranty to include coverage for complete system for failure to meet specified requirements.

### 2 PRODUCTS

#### 2.1 CURTAIN WALL SYSTEM

Manufacturers:

Naturalite/EPI, ridge skylight systems.

Other acceptable manufacturers offering equivalent products.

#### 2.2 MATERIALS

Extruded Aluminum: ASTM B221/B221M.

Sheet Aluminum: ASTM B209/B209M.

Sheet Steel: ASTM A446/A446M; galvanized in accordance with G90 specifications.

Steel Sections: ASTM A36/A36M; shaped to suit mullion sections.

Fasteners: Stainless steel.

## 2.3 COMPONENTS

Mullion Profile: 50 x 100 mm nominal dimension for vertical members, 50 x 150 mm nominal dimension for horizontal members; matching stops and pressure plate of sufficient size and strength to provide bite on glass; drainage holes, deflector plates and internal flashings to accommodate internal weep drainage system; internal mullion baffles to eliminate "stack effect" air movement within internal spaces.

Reinforced Mullion: 50 x 100 mm profile of extruded aluminum cladding with internal reinforcement of shaped steel structural section.

Flashings: thickness as required elsewhere, finish as selected and to match mullion sections where exposed, secured with concealed fastening method.

Louvers (as shown): Extruded aluminum blade and frame, 100 mm deep, 45 degree slope with weatherstop dam; aluminum blank-off panel, at rear for field cutting and sizing to suit mechanical duct attachment, finish same as curtain wall mullion sections. Fabricate rigid to eliminate blade flutter.

Louver Screening: Provide insect/bird screen at exhaust and intake air louver inside surface.

## 2.4 GLASS AND GLAZING MATERIALS

Glass Materials: As specified in Section 08810.

Glazing Materials: As specified in Section 08810.

## 2.5 SEALANT MATERIALS

Sealant and Backing Materials: As specified in Section 07900 of Types described below.

Perimeter Sealant: elastomeric type, or as recommended by manufacturer.

Sealant Used Within System (Not Used for Glazing): elastomeric type, or as recommended by manufacturer.

## 2.6 FINISHES

Exterior Surfaces: Class I, , AA-M10-C22-A44, color anodized finish. Refer to 09915 COLOR SCHEDULE.

Interior Exposed Aluminum Surfaces: Class I, AA-M10-C22-A44, color anodized finish. Refer to 09915 - COLOR SCHEDULE.

Shop and Touch-Up Primer for Steel Components: SSPC Paint 25 red oxide.

Touch-Up Primer for Galvanized Steel Surfaces: SSPC Paint 20 zinc rich.

Concealed Steel Items: Galvanized in accordance with ASTM A123 to 610 gm/sq m).

Apply one coat of bituminous paint to concealed aluminum surfaces in contact with cementitious or dissimilar materials.

### 3 EXECUTION

#### 3.1 FABRICATION

Fabricate system components with minimum clearances and shim spacing around perimeter of assembly, yet enabling installation and dynamic movement of perimeter seal.

Accurately fit and secure joints and corners. Make joints flush, hairline, and weatherproof.

Prepare components to receive anchor devices. Fabricate anchors.

Arrange fasteners and attachments to ensure concealment from view.

Reinforce framing members for external imposed loads.

#### 3.2 EXAMINATION

Verify dimensions, tolerances, and method of attachment with other work.

Verify openings and adjoining air and vapor seal materials are ready to receive work of this Section.

#### 3.3 INSTALLATION

Install curtain wall system in accordance with manufacturer instructions.

Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.

Provide alignment attachments and shims to permanently fasten system to building structure.

Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances and align with adjacent work.

Provide thermal isolation where components penetrate or disrupt building insulation.

Install flashings.

Coordinate installation of and install fire stop at each floor slab edge.

Coordinate attachment and seal of perimeter air barrier and vapor retarder materials.

Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.

Install operating sash glass in accordance with Section 08810, to glazing method required to achieve performance criteria.

Install louvers, associated flashings, blank-off plates and screening. Fit blank-off plates tight to ductwork.

Install glass in accordance with Section 08800, to glazing method required to achieve performance criteria.

Install perimeter sealant to method required to achieve performance criteria. Type, backing materials, and installation criteria in accordance with Section 07900.

### 3.4 ERECTION TOLERANCES

Maximum Variation from Plumb: 1.0 mm/m non-cumulative or 12 mm/30 m, whichever is less.

Maximum Misalignment of Two Adjoining Members Abutting in Plane: 0.8 mm.

Sealant Space Between Curtain Wall Mullions and Adjacent Construction: Maximum of 19 mm and minimum of 6 mm.

### 3.5 CLEANING

Remove protective material from prefinished aluminum surfaces.

Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths. Take care to remove dirt from corners. Wipe surfaces clean.

Remove excess sealant by moderate use of mineral spirits or other solvent acceptable to sealant manufacturer.

### 3.6 PROTECTION OF FINISHED WORK

Protect finished Work from damage.

## SECTION 08952

## TRANSLUCENT PANEL GLAZING SYSTEM

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## ALUMINUM ASSOCIATION (AA)

Designation System for Aluminum Finishes.

## AMERICAN ARCHITECTURAL MANUFACTURERS' ASSOCIATION (AAMA)

Curtain Wall, Window, Store Front and  
Entrance - Guide Specifications Manual

Aluminum Curtain Wall Design Guide Manual

## CURTAIN WALL MANUAL #10

Care and Handling of Architectural Aluminum  
From Shop to Site

## SERIES NO. 11

Design Wind Loads for Buildings and Boundary  
Layer Wind Tunnel Testing

## 501.2

Methods of Test for Metal Curtain Walls

## 603.8

Performance Requirements and Test Procedures  
for Pigmented Organic Coatings on Extruded  
Aluminum

## 605.2

Specification for High Performance Organic  
Coatings on Architectural Extrusions and  
Panels

## 606.1

Specifications and Inspection Methods for  
Integral Color Anodic Finishes for  
Architectural Aluminum

## 607.1

Specifications and Inspection Methods for  
Clear Anodic Finishes for Architectural  
Aluminum

## 608.1

Specification and Inspection Methods for  
Electrolytically Deposited Color Anodic  
Finishes for Architectural Aluminum

## 1502.7

Test Method for Condensation Resistance of  
Windows, Doors, and Glazed Wall Sections

## TIR-A1

Sound Control for Aluminum Curtain Walls and  
Windows

FC-1                      Field Check of Metal Curtain Walls for Water Leakage

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 788                      Calculation of Wind Loads

ASTM C 669                      (1995) Glazing Compounds for Back Bedding and Face Glazing of Metal Sash

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36/36M                      Structural Steel

ASTM A 123                      Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

ASTM A 446/446M                      Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality

ASTM B 209/209M                      Aluminum and Aluminum-Alloy Sheet and Plate

ASTM B 221/221M                      Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes

ASTM E 283                      Test Method for Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors

ASTM E 330                      Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.

ASTM E 331                      Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference

ASTM E 413                      Classification for Rating Sound Insulation

ASTM E 1105                      Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Curtain Walls, and Doors by Uniform or Cyclic Static Air Pressure Difference

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

PAINT 20                      Zinc Rich Coating

PAINT 25                      Red Iron Oxide, Zinc Oxide, Raw Linseed Oil and Alkyd Primer (Without Lead and Chromate Pigments)



## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

### SD-01 Data

Translucent Panel Glazing System; FIO.

Product Data: Provide manufacturer's specifications, standard details, and installation requirements.

### SD-04 Drawings

Translucent Panel Glazing System; GA.

Shop Drawings: Indicate framed opening requirements and tolerances, spacing of all members, anticipated deflection under load, affected related work, expansion and contraction joint locations and details, and sizes and locations for field welding.

### SD-06 Instructions

Translucent Panel Glazing System; FIO.

Manufacturer's preprinted installation instructions and cleaning instructions.

### SD-09 Reports

Translucent Panel Glazing System; FIO.

Test Reports: Submit substantiating engineering data, test results of previous testing of similar assemblies meeting performance criteria, and other supporting data.

### SD-13 Certificates

Translucent Panel Glazing System; FIO.

Certificates stating that the glazing systems are certified conforming to requirements of this section. Labels or markings permanently affixed to the window will be accepted in lieu of certificates.

### SD-14 Samples

Translucent Panel Glazing System; GA.

Manufacturer's standard color samples of the specified finishes.

Samples: Submit two samples 300 x 300 mm in size illustrating prefinished aluminum surface, specified panel with skins, glazing materials illustrating edge and corner.

### 1.3 SYSTEM DESCRIPTION AND REQUIREMENTS

Panel System: Structurally reinforced translucent, with self supporting framing, shop fabricated, factory prefinished, battens, cap strips, related flashings, anchorage and attachment devices.

System Design: Design and size components to withstand dead loads and live loads caused by snow, hail, and positive and negative wind loads acting on plane of panel to a design pressure of 1.0 kPa positive/2.5 kPa negative, as measured in accordance with ASTM E330.

Seismic Loads: Design and size components to withstand seismic loads and sway displacement as calculated in accordance with UBC, latest edition.

Deflection: Limit mullion deflection to 19 mm; with full recovery of glazing materials.

System Assembly: Accommodate without damage to system, components or deterioration of seals; movement within system; movement between system and perimeter framing components; dynamic loading and release of loads; deflection of structural support framing, tolerance of supporting components.

Light Transmission: 70 percent minimum.

Thermal Resistance of Vision Glass Areas: RSI of 0.60.

Sound Attenuation Through Wall System (Exterior to Interior): STC 50, measured in accordance with ASTM E413.

Air Infiltration: Limit air infiltration through assembly to 0.03 l/s/sq m of sloped glazed area, measured at a reference differential pressure across assembly of 75 Pa as measured in accordance with ASTM E283.

Vapor Seal: Limit vapor seal with interior atmospheric pressure of 25 mm sp, 22 degrees C, 40 percent RH without seal failure.

Water Leakage: None, when measured in accordance with ASTM E331.

Expansion / Contraction: System to provide for expansion and contraction within system components caused by a cycling temperature range of 95 degrees C over a 12 hour period without causing detrimental effect to system components.

System Internal Drainage: Drain water entering joints, condensation occurring in framing system, or migrating moisture occurring within system, to the exterior by a weep drainage network.

Air and Vapor Seal: Maintain continuous air barrier and vapor retarder throughout assembly, primarily in line with inside face of glazing panel and heel bead of glazing compound. Position thermal insulation on exterior surface of air barrier and vapor retarder.

Not Permitted: Vibration harmonics, wind whistles, noises caused by thermal movement, thermal movement transmitted to other building elements, loosening, weakening, or fracturing of attachments or components of system.

#### 1.4 QUALITY ASSURANCE

Perform Work in accordance with Aluminum Curtain Wall Design Guide Manual. Maintain one copy on site.

Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience and approved by manufacturer.

Design structural support framing components under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed at the place where the Project is located.

#### 1.5 MOCKUP

Provide 900 x 500 mm mockup including intermediate mullion, sill muntin, and translucent panels. Assemble to illustrate component assembly including glazing materials, weep drainage system, attachments, anchors, and perimeter sealant.

Locate where directed.

Mockup may remain as part of the Work.

#### 1.6 PRE-INSTALLATION MEETING

Convene one week before starting work of this section.

#### 1.7 DELIVERY, STORAGE, AND PROTECTION

Handle work of this Section in accordance with AAMA - Curtain Wall Manual #10.

Protect prefinished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings which bond when exposed to sunlight or weather. Puncture wrappings at ends for ventilation.

#### 1.8 ENVIRONMENTAL REQUIREMENTS

Do not install sealants when ambient temperature is less than that recommended by manufacturer.

Maintain this minimum temperature during and after installation of sealants.

#### 1.9 COORDINATION

Coordinate the Work with installation of firestopping, air barrier placement, vapor retarder placement, and other components or materials.

## 2 PRODUCTS

### 2.1 TRANSLUCENT PANEL SYSTEM

#### Manufacturers:

Kalwall, translucent clamp-tite system.

Other acceptable manufacturers offering equivalent products.

### 2.2 MATERIALS

Extruded Aluminum: ASTM B221/B221M.

Sheet Aluminum: ASTM B209/B209M.

Sheet Steel: ASTM A446/A446M; galvanized in accordance with G90 designation.

Steel Sections: ASTM A36/A36M; shaped to suit mullion sections.

Fasteners: Stainless steel.

### 2.3 COMPONENTS

Panels: Bonded to both sides of structural extruded aluminum grid of pattern as shown; exposed surfaces of exterior sheet chemically and permanently treated to protect against surface erosion and extreme weather conditions; exposed surface of interior sheets fire retardant to a flame/smoke rating of 45/350:

Panel Length: as shown.

Panel Width: as shown.

Panel Depth: as shown.

Panel Thickness: 70 mm.

Facing Sheets: translucent.

Color: color as selected in section 09915 - Color Schedule.

Support Framing Members: sized as shown, if required; of extruded aluminum.

Battens, Cover Strips, Cover Plates, and Integral Flashings: Extruded aluminum, to suit location and application; sized to rigidly retain panels in place.

Flashings: thickness, type as specified elsewhere, secured with concealed fastening method.

Weather Seals: To suit application; non-bleeding; non-staining.

Firestopping: Specified in Section 07270.

### 2.4 GLAZING MATERIALS

Glazing Materials: as specified herein and in section 08810 - Glass and Glazing.

## 2.5 SEALANT MATERIALS

Sealant and Backing Materials: As specified in Section 07900 of Types described below.

Perimeter Sealant: flexible sealing tape or elastomeric type, as recommended by manufacturer.

Sealant Used Within System (Not Used for Glazing): elastomeric type.

## 2.6 FINISHES

Exterior Exposed Aluminum Surfaces: AAMA - A43 anodized to 215-R1 thickness, to color as selected.

Interior Exposed Aluminum Surfaces: PVDF coating, 0.1 mm) thick to color as selected.

Shop and Touch-Up Primer for Steel Components: SSPC Paint 25 red oxide.

Touch-Up Primer for Galvanized Steel Surfaces: SSPC Paint 20 zinc rich.

Concealed Steel Items: Galvanized in accordance with ASTM A123 to 610 gm/sq m).

Apply one coat of bituminous paint to concealed aluminum surfaces in contact with cementitious or dissimilar materials.

## 3 EXECUTION

### 3.1 FABRICATION

Fabricate system components with minimum clearances and shim spacing around perimeter of assembly, yet enabling installation and dynamic movement of perimeter seal.

Accurately fit and secure joints and corners. Make joints flush, hairline, and weatherproof.

Prepare components to receive anchor devices. Fabricate anchors.

Arrange fasteners and attachments to ensure concealment from view.

Reinforce framing members for external imposed loads.

### 3.2 EXAMINATION

Verify dimensions, tolerances, and method of attachment with other work.

Verify wall openings and adjoining air barrier and vapor retarder materials are ready to receive work of this section.

### 3.3 INSTALLATION

Install translucent panel system in accordance with manufacturer instructions. Install cellular panels with cells as shown.

Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.

Provide alignment attachments and shims to permanently fasten system to building structure.

Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances and align with adjacent work.

Provide thermal isolation where components penetrate or disrupt building insulation.

Install flashings.

Coordinate installation of and install air stop at edge of construction.

Coordinate attachment and seal of perimeter air and vapor barrier materials.

Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.

Install perimeter sealant to method required to achieve performance criteria and in accordance with Section 07900.

### 3.4 ERECTION TOLERANCES

Maximum Variation from Plumb: 1.0 mm/m non-cumulative or 12 mm/30 m, whichever is less.

Maximum Misalignment of Two Adjoining Members Abutting in Plane: 0.8 mm.

Sealant Space Between Panel System Members and Adjacent Construction: Maximum of 19 mm and minimum of 6 mm.

### 3.5 CLEANING

Remove protective material from prefinished aluminum surfaces.

Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths. Take care to remove dirt from corners. Wipe surfaces clean.

Remove excess sealant by moderate use of mineral spirits or other solvent acceptable to sealant manufacturer.

### 3.6 PROTECTION OF FINISHED WORK

Protect finished Work from damage.

## SECTION 08960

## SLOPED GLAZING SYSTEM

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## ALUMINUM ASSOCIATION (AA)

Designation System for Aluminum Finishes.

## AMERICAN ARCHITECTURAL MANUFACTURERS' ASSOCIATION (AAMA)

	Metal Curtain Wall, Window, Store Front and Entrance - Guide Specifications Manual
	Aluminum Curtain Wall Design Guide Manual
CURTAIN WALL MANUAL #10	Care and Handling of Architectural Aluminum From Shop to Site
SERIES NO. 11	Design Wind Loads for Buildings and Boundary Layer Wind Tunnel Testing
501.2	Methods of Test for Metal Curtain Walls
603.8	Performance Requirements and Test Procedures for Pigmented Organic Coatings on Extruded Aluminum
605.2	Specification for High Performance Organic Coatings on Architectural Extrusions and Panels
606.1	Specifications and Inspection Methods for Integral Color Anodic Finishes for Architectural Aluminum
607.1	Specifications and Inspection Methods for Clear Anodic Finishes for Architectural Aluminum
608.1	Specification and Inspection Methods for Electrolytically Deposited Color Anodic Finishes for Architectural Aluminum
1502.7	Test Method for Condensation Resistance of Windows, Doors, and Glazed Wall Sections
TIR-A1	Sound Control for Aluminum Curtain Walls and Windows

FC-1                      Field Check of Metal Curtain Walls for Water Leakage

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 788                      Calculation of Wind Loads

ASTM C 669                      (1995) Glazing Compounds for Back Bedding and Face Glazing of Metal Sash

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36/36M                      Structural Steel

ASTM A 123                      Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

ASTM A 446/446M                      Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality

ASTM B 209/209M                      Aluminum and Aluminum-Alloy Sheet and Plate

ASTM B 221/221M                      Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes

ASTM E 283                      Test Method for Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors

ASTM E 330                      Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.

ASTM E 331                      Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference

ASTM E 413                      Classification for Rating Sound Insulation

ASTM E 1105                      Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Curtain Walls, and Doors by Uniform or Cyclic Static Air Pressure Difference

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

PAINT 20                      Zinc Rich Coating

PAINT 25                      Red Iron Oxide, Zinc Oxide, Raw Linseed Oil and Alkyd Primer (Without Lead and Chromate Pigments)



## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

### SD-01 Data

Sloped Glazing; FIO.

Product Data: Provide manufacturer's specifications, standard details, and installation requirements.

### SD-04 Drawings

Sloped Glazing; GA.

Shop Drawings: Indicate framed opening requirements and tolerances, spacing of all members, anticipated deflection under load, affected related work, expansion and contraction joint locations and details, and sizes and locations for field welding.

### SD-06 Instructions

Sloped Glazing System; FIO.

Manufacturer's preprinted installation instructions and cleaning instructions.

### SD-09 Reports

Sloped Glazing; FIO.

Test Reports: Submit substantiating engineering data, test results of previous testing of similar assemblies meeting performance criteria, and other supporting data.

### SD-13 Certificates

Sloped Glazing; FIO.

Certificates stating that the glazing systems are certified conforming to requirements of this section. Labels or markings permanently affixed to the window will be accepted in lieu of certificates.

### SD-14 Samples

Sloped Glazing; GA.

Manufacturer's standard color samples of the specified finishes.

Samples: Submit two samples, not less than 300 mm x 300 mm in size illustrating appearance of prefinished aluminum and specified glazing system, including glazed edge and corner.

### 1.3 SYSTEM DESCRIPTION AND REQUIREMENTS

Sloped Glazing System: Tubular aluminum sections with self supporting framing, factory prefinished, vision glass; related flashings, anchorage and attachment devices.

System Assembly: Site assembled.

System Design: Design and size components to withstand dead loads and live loads caused by positive and negative wind loads acting normal to plane of wall to a design pressure of 1 kPa positive and 2.5 kPa negative.

Seismic Loads: Design and size components to withstand seismic loads and sway displacement as calculated in accordance with UBC (latest edition).

Deflection: Limit mullion deflection to L/360 with full recovery of glazing materials.

System Assembly: System to accommodate without damage to system, components or deterioration of seals, movement within system, movement between system and perimeter framing components, dynamic loading and release of loads, deflection of structural support framing.

Thermal Resistance of Sloped Glazing System (Excluding Vision Areas): N/A.

Thermal Resistance of Vision Areas: N/A.

Water Leakage: None, when measured in accordance with ASTM E331.

Expansion / Contraction: System to provide for expansion and contraction within system components caused by a cycling temperature range of 56 degrees C over a 12 hour period without causing detrimental effect to system components.

System Internal Drainage: Drain water entering joints, condensation occurring in glazing channels, or route moisture occurring within system, to the exterior by a weep drainage network.

Not Permitted: Vibration harmonics, wind whistles, noises caused by thermal movement, thermal movement transmitted to other building elements, loosening, weakening, or fracturing of attachments or components of system.

### 1.4 QUALITY ASSURANCE

Perform Work in accordance with Aluminum Curtain Wall Design Guide Manual. Maintain one copy on site.

Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

Installer Qualifications: Company specializing in performing the work of this section with minimum 3 years documented experience and approved by manufacturer.

Design structural support framing components under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed at the place where the Project is located.

#### 1.5 MOCKUP

Provide one 1 200 mm long x 1 500 wide section of actual assembly for use as mockup including intermediate mullion, edge mullion, intermediate muntin, and vision glass light. Assemble to illustrate component assembly including glazing materials, weep drainage system, attachments, anchors, and perimeter sealant.

Locate where directed.

Mockup may remain as part of the Work.

#### 1.6 PRE-INSTALLATION MEETING

Convene one week before starting work of this section.

#### 1.7 DELIVERY, STORAGE, AND PROTECTION

Handle work of this Section in accordance with Curtain Wall Manual #10.

Protect prefinished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings which bond when exposed to sunlight or weather. Puncture wrappings at ends for ventilation.

#### 1.8 ENVIRONMENTAL REQUIREMENTS

Do not install sealants when ambient temperature is less than that recommended by manufacturer.

Maintain this minimum temperature during and after installation of sealants.

#### 1.9 COORDINATION

Coordinate the Work with installation of firestopping, air barrier placement, vapor retarder placement, installing ductwork to rear of louvers, and other components or materials.

#### 1.10 WARRANTY

Provide a five year warranty to include coverage for complete system for failure to meet specified requirements.

### 2 PRODUCTS

#### 2.1 SLOPED GLAZING SYSTEM

Manufacturers:

Naturalite/EPI, ridge system.

Other acceptable manufacturers offering equivalent products.

## 2.2 MATERIALS

Extruded Aluminum: ASTM B221/B221M.

Sheet Aluminum: ASTM B209/B209M.

Sheet Steel: ASTM A446/A446M; galvanized in accordance with G90 specifications.

Steel Sections: ASTM A36/A36M; shaped to suit mullion sections.

Fasteners: Stainless steel.

## 2.3 COMPONENTS

Mullion Profile: 50 x 100 mm nominal dimension for vertical members, 50 x 150 mm nominal dimension for horizontal members; matching stops and pressure plate of sufficient size and strength to provide bite on glass; drainage holes, deflector plates and internal flashings to accommodate internal weep drainage system; internal mullion baffles to eliminate "stack effect" air movement within internal spaces.

Self Supporting Reinforced Mullion: 50 x 150 mm profile of extruded aluminum cladding with internal reinforcement of shaped steel structural section.

Flashings: thickness as required elsewhere, finish as selected and to match mullion sections where exposed, secured with concealed fastening method.

## 2.4 GLASS AND GLAZING MATERIALS

Glass Materials: As specified in Section 08810.

Glazing Materials: As specified in Section 08810.

## 2.5 SEALANT MATERIALS

Sealant and Backing Materials: As specified in Section 07900 of Types described below.

Perimeter Sealant: elastomeric type, or as recommended by manufacturer.

Sealant Used Within System (Not Used for Glazing): elastomeric type, or as recommended by manufacturer.

## 2.6 FINISHES

Exterior Surfaces: Class I, , AA-M10-C22-A44, color anodized finish. Refer to 09915 COLOR SCHEDULE.

Interior Exposed Aluminum Surfaces: Class I, AA-M10-C22-A44, color anodized finish. Refer to 09915 - COLOR SCHEDULE.

Shop and Touch-Up Primer for Steel Components: SSPC Paint 25 red oxide.

Touch-Up Primer for Galvanized Steel Surfaces: SSPC Paint 20 zinc rich.

Concealed Steel Items: Galvanized in accordance with ASTM A123 to 610 gm/sq m).

Apply one coat of bituminous paint to concealed aluminum surfaces in contact with cementitious or dissimilar materials.

### 3 EXECUTION

#### 3.1 FABRICATION

Fabricate sloped glazing components with minimum clearances and shim spacing around perimeter of assembly, yet enabling installation and dynamic movement of perimeter seal.

Accurately fit and secure joints and corners. Make joints flush, hairline, and weatherproof.

Prepare components to receive anchor devices. Fabricate anchors.

Arrange fasteners and attachments to ensure concealment from view.

Reinforce framing members for external imposed loads.

#### 3.2 EXAMINATION

Verify dimensions, tolerances, and method of attachment with other work.

Verify openings and adjoining air and vapor seal materials are ready to receive work of this Section.

#### 3.3 INSTALLATION

Install sloped glazing system in accordance with manufacturer instructions.

Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.

Provide alignment attachments and shims to permanently fasten system to building structure.

Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances and align with adjacent work.

Provide thermal isolation where components penetrate or disrupt building insulation.

Install flashings.

Coordinate installation of and install fire stop at system perimeter, if required.

Coordinate attachment and seal of perimeter air and vapor barrier materials.

Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.

Install glass in accordance with Section 08810, to glazing method required to achieve performance criteria. Place sealant on the upslope side of the pressure plate cover caps; finish the surface with a slope for drainage over the cap, or as recommended by manufacturer.

Install perimeter sealant to method required to achieve performance criteria. Type, backing materials, and installation criteria in accordance with Section 07900.

### 3.4 ERECTION TOLERANCES

Maximum Variation from True Alignment: 1.0 mm/m non-cumulative or 12 mm/30 m), whichever is less.

Maximum Misalignment of Two Adjoining Members Abutting in Plane: 0.8 mm.

Sealant Space Between Sloped Glazing Mullions and Adjacent Construction: Maximum of 19 mm and minimum of 6 mm.

### 3.5 CLEANING

Remove protective material from prefinished aluminum surfaces.

Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths. Take care to remove dirt from corners. Wipe surfaces clean.

Remove excess sealant by moderate use of mineral spirits or other solvent acceptable to sealant manufacturer.

### 3.6 PROTECTION OF FINISHED WORK

Protect finished Work from damage.

## SECTION 09250

## GYPSUM WALLBOARD

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 840 (1994) Application and Finishing of Gypsum Board

## FACTORY MUTUAL ENGINEERING AND RESEARCH (FM)

FM P8016 (1993) Specification Tested Products Guide

## GYPSUM ASSOCIATION (GA)

GA 600 (1992) Fire Resistance Design Manual

## UNDERWRITERS LABORATORIES (UL)

UL-05 (1993; supple) Fire Resistance Directory

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL DESCRIPTIONS:

## SD-04 Drawings

Steel Framing; FIO.  
Control Joints; FIO.  
Fire-Resistant Assemblies; FIO.

Drawings and installation details for ceiling framing, furring, special wall framing, and framed openings in walls and ceilings.

## SD-06 Instructions

Manufacturers Recommendations; FIO.

Preprinted material describing installation of a product, system and material.

## SD-13 Certificates

Gypsum Wallboard; FIO.  
Water-Resistant Gypsum Board; FIO.  
Steel Framing; FIO.

Certificates stating that the steel framing and gypsum wallboard meet the specified requirements.

## 1.3 QUALIFICATIONS

Manufacturer shall specialize in manufacturing the types of material specified and shall have a minimum of 10 years of documented successful experience. Installer shall specialize in the type of gypsum board work required and shall have a minimum of 5 years of documented successful experience.

## 2 MATERIALS

Unless otherwise specified or shown, gypsum wallboard materials, including gypsum board, framing members, fasteners, finishing materials, accessories, and other applicable materials shall conform to ASTM C 840. Water-resistant gypsum board shall be Type X, with water-resistant paper faces. Accessories such as hangars, tie wire, clips, rings and other fastenings not specified in ASTM C 840 or standards referenced therein shall conform to the gypsum board manufacturer's written recommended requirements.

## 3 EXECUTION

## 3.1 APPLICATION OF GYPSUM BOARD

Gypsum board shall be installed in accordance with ASTM C 840 and as the standards referenced therein and as specified herein.

## 3.2 FIRE-RESISTANT ASSEMBLIES

Gypsum wallboard construction for fire-rated assemblies shall be in accordance with UL-05, FM P8016 or GA 600 for the design indicated on drawings.

## 3.2.1 Fire-Rated Construction

Joints of fire-rated gypsum board enclosures shall be closed and sealed in accordance with UL requirements, and as required to meet pressurization requirements. Penetrations through rated partitions and ceilings shall be sealed tight with rated firestopping materials.

## 3.2.2 Pressurized Enclosures

Pressurized fire-rated gypsum board enclosures shall allow the mechanical and electrical life-safety systems to operate in accordance with the design intent. Air pressure within elevator shaft shall be 360 Pa. Air pressure within stair shaft shall be 240 Pa. Maximum mid-span deflection shall be  $L/360$ .



## SECTION 09310

## CERAMIC TILE

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A108.1A	(1992) Installation of Ceramic Tile in the Wet-Set Method, with Portland Cement Mortar
ANSI A108.1B	(1992) Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-Set or Latex Portland Cement Mortar
ANSI A108.4	(1992) Installation of Ceramic Tile with Organic Adhesives or Water Cleanable Tile Setting Epoxy Adhesive
ANSI A108.5	(1992) Installation of Ceramic Tile with Dry-Set Portland Cement Mortar or Latex-Portland Cement Mortar
ANSI A108.6	(1992) Installation of Ceramic Tile with Chemical Resistant, Water Cleanable Tile-Setting and Grouting Epoxy
ANSI A108.10	(1992) Installation of Grout in Tilework
ANSI A108.11	(1992) Interior Installation of Cementitious Backup Units
ANSI A118.1	(1992) Dry-Set Portland Cement Mortar
ANSI A118.3	(1992) Chemical Resistant, Water Cleanable Tile Setting and Grouting Epoxy and Water Cleanable Tile Setting Epoxy Adhesive
ANSI A118.9	(1992) Test Methods and Specifications for Cementitious Backer Units
ANSI A136.1	(1992) Organic Adhesives for Installation of Ceramic Tile
ANSI A137.1	(1988) Ceramic Tile

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 33	(1993) Concrete Aggregates
ASTM C 144	(1993) Aggregate for Masonry Mortar

ASTM C 150	(1996) Portland Cement
ASTM C 206	(1984; R 1992) Finishing Hydrated Lime
ASTM C 207	(1991; R 1992) Hydrated Lime for Masonry Purposes
ASTM C 241	(1990) Abrasion Resistance of Stone Subjected to Foot Traffic
ASTM C 373	(1988; R 1994) Water Absorption, Bulk Density, Apparent Porosity, and Apparent Specific Gravity of Fired Whiteware Products
ASTM C 648	(1984; R 1994) Breaking Strength of Ceramic Tile
ASTM C 1026	(1987; R 1992) Measuring the Resistance of Ceramic Tile to Freeze-Thaw Cycling
ASTM C 1027	(1984; R 1990) Determining Visible Abrasion Resistance of Glazed Ceramic Tile
ASTM C 1028	(1989) Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method

## MARBLE INSTITUTE OF AMERICA (MIA)

MIA-01	(1991) Design Manual IV Dimensional Stone
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## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 99	(1996) Health Care Facilities
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## TILE COUNCIL OF AMERICA (TCA)

TCA-01	(1995) Handbook for Ceramic Tile Installation
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## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

SD-01 Data

Tile; FIO.  
Setting-Bed; FIO.  
Mortar, Grout, and Adhesive; FIO.

Manufacturer's catalog data.

## SD-06 Instructions

Tile; FIO.

Mortar and Grout; FIO.

Manufacturers preprinted installation and cleaning instructions.

## SD-13 Certificates

Tile; FIO.

Mortar, Grout, and Adhesive; FIO.

Certificates indicating conformance with specified requirements. A master grade certificate shall be furnished for tile.

## SD-14 Samples

Tile; GA.

Accessories; GA.

Marble Thresholds; GA.

Samples of sufficient size to show color range, pattern, type and joints.

## 1.3 DELIVERY AND STORAGE

Materials shall be delivered to the project site in manufacturer's original unopened containers with seals unbroken and labels and hallmarks intact. Materials shall be kept dry, protected from weather, and stored under cover.

## 1.4 ENVIRONMENTAL REQUIREMENTS

Ceramic tile work shall not be performed unless the substrate and ambient temperature is at least 10 degrees C and rising. Temperature shall be maintained above 10 degrees C while the work is being performed and for at least 7 days after completion of the work. When temporary heaters are used they shall be vented to the outside to avoid carbon dioxide damage to new tilework.

## 1.5 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a 1-year period shall be provided.

## 2 PRODUCTS

## 2.1 TILE

Tile shall be standard grade conforming to ANSI A137.1. Containers shall be grade sealed. Seals shall be marked to correspond with the marks on the signed master grade certificate. Tile shall be impact resistant with a minimum breaking strength for wall tile of 41 kg and 113 kg for floor tile in accordance with ASTM C 648. Tile for cold climate projects shall be rated frost resistant by the manufacturer as determined by ASTM C 1026. Water absorption shall be 0.5 maximum percent in accordance with ASTM C 373. Floor tile shall have a minimum static coefficient of friction of 0.5 in accordance with ASTM C 1028. Tile shall be Class III as rated by the

manufacturer when tested in accordance with ASTM C 1027 for abrasion resistance as related to foot traffic.

#### 2.1.1 Mosaic Tile

Ceramic mosaic tile and trim shall be unglazed with cushion edges. Tile size shall be 50 x 50 mm. Color shall be in accordance with Section 09915 COLOR SCHEDULE.

#### 2.1.2 Glazed Wall Tile

Glazed wall tile and trim shall be cushion edged with bright glaze. Tile shall be 106 x 106 mm. Color shall be in accordance with Section 09915 COLOR SCHEDULE.

#### 2.1.3 Accessories

Accessories shall be the built-in type of the same materials and finish as the wall tile. Accessories shall be provided as shown.

### 2.2 SETTING-BED

The setting-bed shall be composed of the following:

#### 2.2.1 Aggregate for Concrete Fill

Aggregate shall conform to ASTM C 33. Maximum size of coarse aggregate shall not be greater than one-half the thickness of concrete fill.

#### 2.2.2 Portland Cement

Cement shall conform to ASTM C 150, Type I, white for wall mortar and gray for other uses.

#### 2.2.3 Sand

Sand shall conform to ASTM C 144.

#### 2.2.4 Hydrated Lime

Hydrated lime shall conform to ASTM C 206, Type S or ASTM C 207, Type S.

### 2.3 WATER

Water shall be potable.

### 2.4 MORTAR, GROUT, AND ADHESIVE

Mortar, grout, and adhesive shall conform to the following:

#### 2.4.1 Dry-Set Portland Cement Mortar

ANSI A118.1.

#### 2.4.2 Organic Adhesive

ANSI A136.1, Type I.

#### 2.4.3 Epoxy Resin Grout

ANSI A118.3.

#### 2.4.4 Cementitious Backer Board

Cementitious backer units shall comply with ANSI A118.9.

### 2.5 MARBLE THRESHOLDS

Marble thresholds shall be of size required by drawings or conditions. Marble shall be Group A as classified by MIA-01. Marble shall have a fine sand-rubbed finish and shall be white in color as approved by the Contracting Officer. Marble abrasion shall be not less than 12.0 when tested in accordance with ASTM C 241.

## 3 EXECUTION

### 3.1 PREPARATORY WORK AND WORKMANSHIP

Surface to receive tile shall be inspected and shall conform to the requirements of ANSI A108.1A or ANSI A108.1B for surface conditions for the type setting bed specified and for workmanship. Variations of surface to be tiled shall fall within maximum values shown below:

TYPE	WALLS	FLOORS
Dry-Set Mortar	3 mm in 2.4 meters	3.0 mm in 3 meters
Organic Adhesives	3 mm in 2.4 meters	1.5 mm in 1 meters
Latex portland cement mortar	3 mm in 2.4 meters	3.0 mm in 3 meters
Epoxy	3 mm in 2.4 meters	3.0 mm in 3 meters

### 3.2 GENERAL INSTALLATION REQUIREMENTS

Tile work shall not be started until roughing in for mechanical and electrical work has been completed and tested, and built-in items requiring membrane waterproofing have been installed and tested. Floor tile installation shall not be started in spaces requiring wall tile until after wall tile has been installed. Tile in colors and patterns indicated shall be applied in the area shown on the drawings. Tile shall be installed with the respective surfaces in true even planes to the elevations and grades shown. Special shapes shall be provided as required for sills, jambs, recesses, offsets, external corners, and other conditions to provide a complete and neatly finished installation. Tile bases and coves shall be solidly backed with mortar.

### 3.3 INSTALLATION OF WALL TILE

Wall tile shall be installed in accordance with the TCA-01, method W-242 or W-243.

#### 3.3.1 Workable or Cured Mortar Bed

Tile shall be installed over a workable mortar bed or a cured mortar bed at the option of the Contractor. A 0.102 mm polyethylene membrane, metal lath, and scratch coat shall also be installed. Workable mortar bed, materials,

and installation of tile shall conform to ANSI A108.1A. Cured mortar bed and materials shall conform to ANSI A108.1B.

### 3.3.2 Dry-Set Mortar and Latex-Portland Cement Mortar

Dry-set, Latex-portland cement or organic adhesive shall be used to install tile in accordance with ANSI A108.5. Latex portland cement shall be used when installing porcelain ceramic tile.

### 3.3.3 Organic Adhesive

Organic adhesive installation of ceramic tile shall conform to ANSI A108.4.

## 3.4 INSTALLATION OF FLOOR TILE

Floor tile shall be installed in accordance with TCA-01, method F-115.

### 3.4.1 Workable or Cured Mortar Bed

Floor tile shall be installed over a workable mortar bed or a cured mortar bed at the option of the Contractor. Workable mortar bed materials and installation shall conform to ANSI A108.1A. Cured mortar bed and materials shall conform to ANSI A108.1B.

### 3.4.2 Dry-Set and Latex-Portland Cement

Dry-set or Latex-portland cement mortar shall be used to install tile directly over properly cured, plane, clean concrete slabs in accordance with ANSI A108.5. Latex portland cement shall be used when installing porcelain ceramic tile.

### 3.4.3 Resinous Grout

When resinous grout is indicated, quarry tile shall be grouted with epoxy resin grout. Joints shall be raked and cleaned to the full depth of the tile and neutralized when recommended by the resin manufacturer. Epoxy resin grout shall be installed in conformance with ANSI A108.6. Installation of resin grout shall be in strict accordance with manufacturer's instructions for proportioning, mixing, installing, and curing. Recommended temperature shall be maintained in the area and on the surface to be grouted. After grouting, tile shall be left free of grout stain.

### 3.4.4 Ceramic Tile Grout

Ceramic Tile grout shall be prepared and installed in accordance with ANSI A108.10.

### 3.4.5 Cementitious Backer Board

Cementitious backer units shall be installed in accordance with ANSI A108.11. Fasteners shall be type designed for cement board application.

## 3.5 INSTALLATION OF MARBLE THRESHOLDS

Thresholds shall be installed where indicated in a manner similar to that of the ceramic tile floor. Thresholds shall be the full width of the opening.

Head joints at ends shall not exceed 6 mm in width and shall be grouted full as specified for ceramic tile.

### 3.6 TESTING

Electrical resistance tests shall be performed on conductive flooring in the presence of the Contracting Officer by a technician experienced in such work and a copy of the test results shall be furnished. Test procedures, testing apparatus, and test results shall be in accordance with the provisions for Conductive Flooring in NFPA 99.

### 3.7 CONTROL JOINTS

Joints shall be formed as indicated and sealed as specified in Section 07900 JOINT SEALING.

#### 3.7.1 Walls

Control joints shall be provided at control joints in backing material. Wherever backing material changes, a control joint shall be formed to separate the different materials.

#### 3.7.2 Floors

Control joints shall be provided over construction joints, control joints, and expansion joints in concrete slabs. Control joints shall also be provided where tile abuts restraining surfaces such as perimeter walls, curbs and columns and at intervals of 7.2 to 10.8 m each way in large interior floor areas and 3.6 to 4.8 m each way in large exterior areas or areas exposed to direct sunlight or moisture. Expansion joints shall extend through setting-beds and fill.

### 3.8 CLEANING AND PROTECTING

Upon completion, tile surfaces shall be thoroughly cleaned in accordance with manufacturer's approved cleaning instructions. Acid shall not be used for cleaning glazed tile. Floor tile with resinous grout or with factory mixed grout shall be cleaned in accordance with instructions of the grout manufacturer. After the grout has set, tile wall surfaces shall be given a protective coat of a noncorrosive soap or other approved method of protection. Tiled floor areas shall be covered with building paper before foot traffic is permitted over the finished tile floors. Board walkways shall be laid on tiled floors that are to be continuously used as passageways by workmen. Damaged or defective tiles shall be replaced.

## SECTION 09510

## ACOUSTICAL CEILINGS

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 635	(1995) Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings
ASTM C 636	(1992) Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings
ASTM E 1264	(1990) Standard Classification for Acoustical Ceiling Products
ASTM E 1414	(1991a) Standard Test for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum.

## 1.2 GENERAL REQUIREMENTS

Acoustical treatment shall consist of sound controlling units mechanically mounted on a ceiling suspension system. The unit size, texture, finish, and color shall be as specified. The location and extent of acoustical treatment shall be as shown on the drawings.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

## SD-01 Data

Acoustical Ceiling System; FIO.

Manufacturer's descriptive data, catalog cuts, and installation instructions.

## SD-04 Drawings

Acoustical Ceiling System; FIO.

Drawings showing suspension system, method of anchoring and fastening, details, and reflected ceiling plan.



## SD-13 Certificates

Acoustical Units; FIO.

Certificate attesting that the mineral based acoustical units furnished for the project contains recycled material and showing an estimated percent of such material.

## SD-14 Samples

Acoustical Units; GA.

Two samples of each type of acoustical unit and each type of suspension grid tee section showing texture, finish, and color.

## 1.4 DELIVERY AND STORAGE

Materials shall be delivered to the site in the manufacturer's original unopened containers with brand name and type clearly marked. Materials shall be carefully handled and stored in dry, watertight enclosures. Immediately before installation, acoustical units shall be stored for not less than 24 hours at the same temperature and relative humidity as the space where they will be installed in order to assure proper temperature and moisture acclimation.

## 1.5 ENVIRONMENTAL REQUIREMENTS

A uniform temperature of not less than 16 degrees C nor more than 29 degrees C and a relative humidity of not more than 70 percent shall be maintained before, during, and after installation of acoustical units.

## 1.6 SCHEDULING

Interior finish work such as plastering, concrete and terrazzo work shall be complete and dry before installation. Mechanical, electrical, and other work above the ceiling line shall be completed and heating, ventilating, and air conditioning systems shall be installed and operating in order to maintain temperature and humidity requirements.

## 1.7 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one year period shall be provided.

## 1.8 EXTRA MATERIALS

## 1.8.1 Barracks

Spare tiles of each color shall be furnished at the rate of 5 extra tiles for each 1000 tiles installed. Tiles shall be from the same lot as those installed.

## 1.8.2 Community Building

Spare tiles of each color shall be furnished at the rate of 50 tiles for each 1000 tiles installed. Tiles shall be from the same lot as those installed.

## 2 PRODUCTS

### 2.1 ACOUSTICAL UNITS

Acoustical units shall conform to ASTM E 1264, Class A, and the following requirements:

#### 2.1.1 Units for Exposed-Grid System (barracks)

Type: N/A.

Minimum NRC: 0.9

Pattern: Units shall be similar to 'Tectum Acousti-Tough 'Designer Plus', or approved equal.

Nominal size: 610 mm by 610 mm by 25 mm thickness.

Edge detail: beveled tegular.

Finish: Factory-applied white finish.

Minimum LR coefficient: 0.65.

Minimum CAC: N/A.

#### 2.1.2 Units for Exposed-Grid System A (community building)

Type: III (mineral fiber with painted finish).

Minimum NRC: 0.55 when tested on mounting No. E-400

Pattern: CE (fissured) Units shall have be similar to 'Armstrong Designer Minatone' 713, or approved equal.

Nominal size: 610 mm by 610 mm.

Edge detail: beveled tegular.

Finish: Factory-applied white finish.

Minimum LR coefficient: 0.80.

Minimum CAC: 35.

#### 2.1.3 Units for Exposed-Grid System B (community building)

Type: III (mineral fiber with painted finish).

Minimum NRC: 0.55 when tested on mounting No. E-400

Pattern: D (fissured) Units shall be similar to Armstrong 'SupraFine 2200' no. 6407, or approved equal.

Nominal size: 610 mm by 610 mm.

Edge detail: angled tegular.

Finish: Factory-applied white finish.

Minimum LR coefficient: 0.80.

Minimum CAC: 35.

### 2.2 SUSPENSION SYSTEM

Suspension system shall be exposed-grid and have narrow width flange - 14 mm wide, and shall conform to ASTM C 635 for intermediate-duty systems. Surfaces exposed to view shall be aluminum or steel with a factory-applied white baked-enamel finish. Wall molding shall have a flange of not less than 23 mm. Inside corner caps shall be provided where necessary to produce an acceptable workmanlike appearance.

### 2.3 HANGERS

Hangers shall be galvanized steel wire. Hangers and attachment shall support a minimum 1330 N ultimate vertical load without failure of supporting material or attachment.

### 2.4 ACCESS PANELS

Access panels shall match adjacent acoustical units and shall be designed and equipped with suitable framing and fastenings for removal and replacement without damage. Panel shall be not less than 300 by 300 mm or more than 300 by 600 mm. An identification plate of 0.8 mm thick aluminum, 19 mm in diameter, stamped with the letters "AP" and finished the same as the unit, shall be attached near one corner on the face of each access panel.

### 2.5 FINISHES

Acoustical units and suspension system members shall have manufacturer's standard textures, patterns and finishes as specified. Ceiling suspension system components shall be treated to inhibit corrosion.

### 2.6 COLORS AND PATTERNS

Colors and patterns for acoustical units and suspension system components shall be as specified in Section 09915 COLOR SCHEDULE.

### 2.7 CEILING ATTENUATION CLASS AND TEST

Ceiling attenuation class (CAC) range of acoustical units, when required, shall be determined in accordance with ASTM E 1414. Test ceiling shall be continuous at the partition and shall be assembled in the suspension system in the same manner that the ceiling will be installed on the project. System shall be tested with all acoustical units installed.

## 3 EXECUTION

### 3.1 INSTALLATION

Acoustical work shall be provided complete with necessary fastenings, clips, and other accessories required for a complete installation. Mechanical fastenings shall not be exposed in the finished work. Hangers shall be laid out for each individual room or space. Hangers shall be placed to support framing around beams, ducts, columns, grilles, and other penetrations through ceilings. Main runners and carrying channels shall be kept clear of abutting walls and partitions. At least two main runners shall be provided for each ceiling span. Wherever required to bypass an object with the hanger wires, a sub-suspension system shall be installed, so that all hanger wires will be plumb.

#### 3.1.1 Suspension System

Suspension system shall be installed in accordance with ASTM C 636 and as specified herein. There shall be no hanger wires or other loads suspended from underside of steel decking.

#### 3.1.1.1 Plumb Hangers

Hangers shall be plumb and shall not press against insulation covering ducts and pipes.

#### 3.1.1.2 Splayed Hangers

Where hangers must be splayed (sloped or slanted) around obstructions, the resulting horizontal force shall be offset by bracing, countersplaying, or other acceptable means.

#### 3.1.2 Wall Molding

Wall molding shall be provided where ceilings abut vertical surfaces. Wall molding shall be secured not more than 75 mm from ends of each length and not more than 400 mm on centers between end fastenings. Wall molding springs shall be provided at each acoustical unit in semi-exposed or concealed systems.

#### 3.1.3 Acoustical Units

Acoustical units shall be installed in accordance with the approved installation instructions of the manufacturer. Edges of acoustical units shall be in close contact with metal supports, with each other, and in true alignment. Acoustical units shall be arranged so that units less than one-half width are minimized. Units in exposed-grid system shall be held in place with manufacturer's standard hold-down clips, if units weigh less than 5 kg per square m or if required for fire resistance rating.

#### 3.2 CEILING ACCESS PANELS

Ceiling access panels shall be located directly under the items which require access.

#### 3.3 CLEANING

Following installation, dirty or discolored surfaces of acoustical units shall be cleaned and left free from defects. Units that are damaged or improperly installed shall be removed and new units provided as directed.

## SECTION 09650

## RESILIENT FLOORING

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 4078	(1992; R 1996) Water Emulsion Floor Polish
ASTM E 648	(1997) Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source
ASTM E 662	(1994a) Specific Optical Density of Smoke Generated by Solid Materials
ASTM F 1066	(1995a) Vinyl Composition Floor Tile
ASTM F 1303	(1996) Sheet Vinyl Floor Covering with Backing

## FEDERAL SPECIFICATIONS (FS)

FS SS-T-312	(Rev B; Int Am 1; Notice 1) Tile, Floor: Asphalt, Rubber, Vinyl, and Vinyl Composition
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## 1.2 FIRE RESISTANCE REQUIREMENTS

Flooring in corridors and exits shall have a minimum average critical radiant flux of 0.45 watts per square centimeter when tested in accordance with ASTM E 648. The smoke density rating shall be less than 450 when tested in accordance with ASTM E 662.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

## SD-01 Data

Resilient Flooring and Accessories; FIO.

Manufacturer's descriptive data and installation instructions including cleaning and maintenance instructions.

## SD-09 Reports

Resilient Flooring and Accessories; FIO.

Copies of test reports showing that representative product samples of the flooring proposed for use have been tested by an independent testing laboratory within the past three years or when formulation change occurred and conforms to the requirements specified.

#### SD-14 Samples

Resilient Flooring and Accessories; GA.

Three samples of each indicated color and type of flooring and base. Sample size shall be minimum 60 by 100 mm.

### 1.4 DELIVERY AND STORAGE

Materials shall be delivered to the building site in original unopened containers bearing the manufacturer's name, project identification, and handling instructions. Materials shall be stored in a clean dry area with temperature maintained above 21 degrees C for 2 days prior to installation, and shall be stacked according to manufacturer's recommendations. Materials shall be protected from the direct flow of heat from hot-air registers, radiators and other heating fixtures and appliances.

### 1.5 ENVIRONMENTAL REQUIREMENTS

Areas to receive resilient flooring shall be maintained at a temperature above 21 degrees C and below 38 degrees C for 2 days before application, during application and 2 days after application. A minimum temperature of 13 degrees C shall be maintained thereafter.

### 1.6 SCHEDULING

Resilient flooring application shall be scheduled after the completion of other work which would damage the finished surface of the flooring.

### 1.7 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one year period shall be provided.

### 1.8 EXTRA MATERIALS

Extra flooring material of each color and pattern shall be furnished at the rate of 5 tiles for each 1000 tiles and 0.5 square meters for each 92 square meters of sheet flooring] installed. Extra materials shall be from the same lot as those installed. Extra base material composed of 6 m of each color shall be furnished.

## 2 PRODUCTS

### 2.1 VINYL-COMPOSITION TILE TYPE

Vinyl-composition tile shall conform to ASTM F 1066, Class 2, (through pattern tile), Composition 1, asbestos-free, and shall be 305 mm square and 3.2 mm thick. Tile shall have the color and pattern uniformly distributed throughout the thickness of the tile. Flooring in any one continuous area shall be from the same lot and shall have the same shade and pattern.

## 2.2 SHEET VINYL FLOORING

Sheet vinyl flooring shall be composed of a homogeneous, vinyl composition. Flooring shall be not less than 1800 mm wide. Sheet vinyl flooring with backing shall conform to ASTM F 1303, Type II, Grade 1 and shall have minimum wear layer thickness 1.73 mm and minimum overall thickness 2.08 mm. Average weight shall be 3.04 kg/SM. The solid vinyl color and pattern shall extend through the total thickness of the material. High quality vinyl welding rods for heat welding of joints shall be provided. A 5 year commercial warranty shall be provided.

## 2.3 SOLID VINYL TILE

Solid vinyl tile shall conform to FS SS-T-312 Type III. Tile shall be 305 mm square by 3.2 mm thick. Tiles shall be of solid un laminated construction.

## 2.4 RESILIENT BASE

Base shall be manufacturers standard rubber, straight style (installed with carpet) and coved style (installed with resilient flooring). Base shall be 100 mm high and a minimum 3 mm thick. Preformed outside corners shall be furnished.

## 2.5 TRANSITION STRIP

A rubber transition strip tapered to meet abutting material shall be provided.

## 2.6 ADHESIVE

Adhesive for flooring and wall base shall be as recommended by the flooring manufacturer.

## 2.7 POLISH

Polish shall conform to ASTM D 4078.

## 2.8 CAULKING AND SEALANTS

Caulking and sealants shall be in accordance with Section 07900 JOINT SEALING.

## 2.9 MANUFACTURER'S COLOR AND TEXTURE

Color and texture shall be in accordance with Section 09915 COLOR SCHEDULE.

## 3 EXECUTION

### 3.1 EXAMINATION/VERIFICATION OF CONDITIONS

The Contractor shall examine and verify that site conditions are in agreement with the design package and shall report all conditions that will prevent a proper installation. The Contractor shall not take any corrective action without written permission from the Government.

### 3.2 SURFACE PREPARATION

Flooring shall be in a smooth, true, level plane, except where indicated as sloped. Before any work under this section is begun, all defects such as rough or scaling concrete, low spots, high spots, and uneven surfaces shall have been corrected, and all damaged portions of concrete slabs shall have been repaired as recommended by the flooring manufacturer. Concrete curing compounds, other than the type that does not adversely affect adhesion, shall be entirely removed from the slabs. Paint, varnish, oils, release agents, sealers, waxers, and adhesives shall be removed, as recommended by the flooring manufacturer.

### 3.3 MOISTURE TEST

The suitability of the concrete subfloor for receiving the resilient flooring with regard to moisture content shall be determined by a moisture test as recommended by the flooring manufacturer.

### 3.4 INSTALLATION OF VINYL-COMPOSITION TILE AND SOLID VINYL TILE

Tile flooring shall be installed with adhesive in accordance with the manufacturer's installation instructions. Tile lines and joints shall be kept square, symmetrical, tight, and even. Edge width shall vary as necessary to maintain full-size tiles in the field, but no edge tile shall be less than one-half the field tile size, except where irregular shaped rooms make it impossible. Flooring shall be cut to, and fitted around, all permanent fixtures, built-in furniture and cabinets, pipes, and outlets. Edge tile shall be cut, fitted, and scribed to walls and partitions after field flooring has been applied.

### 3.5 INSTALLATION OF SHEET VINYL FLOORING

Sheet vinyl flooring shall be installed with adhesive in accordance with the manufacturer's written installation instructions. Flooring shall be fitted to the room by hand cutting, straight scribing, or pattern scribing as necessary to suit job conditions. Flooring shall be cut to, and fitted around, all permanent fixtures, built-in furniture and cabinets, pipes, and outlets. Seams shall be cut by overlapping or underscribing as recommended by the manufacturer. Seams and edges of sheet vinyl flooring shall be bonded or welded as recommended by the manufacturer.

### 3.6 INSTALLATION OF FEATURE STRIPS

Edge strips shall be secured with adhesive as recommended by the manufacturer. Edge strips shall be provided at locations where flooring termination is higher than the adjacent finished flooring, except at doorways where thresholds are provided.

### 3.7 INSTALLATION OF RESILIENT BASE

Wall base shall be installed with adhesive in accordance with the manufacturer's written instructions. Base joints shall be tight and base shall be even with adjacent resilient flooring. Voids along the top edge of base at masonry walls shall be filled with caulk.



### 3.8 CLEANING

Immediately upon completion of installation of tile in a room or an area, flooring and adjacent surfaces shall be cleaned to remove all surplus adhesive. After installation, flooring shall be washed with a cleaning solution, rinsed thoroughly with clear cold water, and, except for raised pattern rubber flooring, rubber tile and sheet rubber flooring, rubber stair treads, and static control vinyl tile, given two coats of polish in accordance with manufacturers written instructions. After each polish coat, floors shall be buffed to an even luster with an electric polishing machine. Raised pattern rubber flooring, rubber tile and sheet rubber flooring, rubber stair treads, and static control vinyl tile shall be cleaned and maintained as recommended by the manufacturer.

### 3.9 PROTECTION

From the time of laying until acceptance, flooring shall be protected from damage as recommended by the flooring manufacturer. Flooring which becomes damaged, loose, broken, or curled shall be removed and replaced.

## SECTION 09680

## CARPET

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS (AATCC)

AATCC TM-16	(1993) Test Method: Colorfastness to Light
AATCC TM-134	(1991) Test Method: Electrostatic Propensity of Carpets
AATCC TM-165	(1993) Test Method: Colorfastness to Crocking: Carpets - AATCC Crockmeter Method
AATCC TM-174	(1993) Test Method: Antimicrobial Activity Assessment of Carpet

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 418	(1993) Pile Yarn Floor Covering Construction
ASTM D 1423	(1992) Twist in Yarns by the Direct Counting Method
ASTM D 3278	(1989) Test Methods for Flash Point of Liquids by Setaflash Closed-Cup Apparatus
ASTM E 648	(1996a) Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source

## CARPET AND RUG INSTITUTE (CRI)

CRI 104	(1994) Commercial Carpet Installation Standard
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## CODE OF FEDERAL REGULATIONS (CFR)

16 CFR 1630	Standard for the Surface Flammability of Carpet and Rugs
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## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

## SD-01 Data

Carpet and Accessories; FIO.

Manufacturer's catalog data and printed documentation stating physical characteristics, durability, resistance to fading, and flame resistance characteristics for each type of carpet material and installation accessory.

## SD-04 Drawings

Installation; FIO.

Three copies of drawings indicating areas receiving carpet, carpet types, textures and patterns, direction of pile, location of seams, and locations of edge molding.

## SD-06 Instructions

Carpet and Accessories; FIO.

Copies of the manufacturer's printed installation instructions for the carpet, including preparation of substrate, seaming techniques, and recommended adhesives and tapes.

## SD-09 Reports

Certified Lab and Test Reports; FIO.

Certified copies of test reports specified herein for flammability and static propensity of the specified carpet that has been submitted for approval by the Contracting Officer. Testing shall have been performed by an independent testing laboratory within two years of submittal of the report for approval.

## SD-13 Certificates

Carpet and Accessories; FIO.

Certificates of compliance from a laboratory accredited by the National Laboratory Accreditation Program of the National Institute of Standards and Technology attesting that each type of carpet and carpet with cushion material conforms to the standards specified.

## SD-14 Samples

Carpet and Accessories; GA.

- a. Carpet: Two "Production Quality" samples 675 x 450 mm of each carpet proposed for use, showing quality, pattern, and color specified.
- b. Vinyl or Aluminum Moldings: Two pieces of each type at least 300 mm.
- c. Special Treatment Materials: Two samples showing system and installation method.

## SD-19 Operation and Maintenance Manuals

## Carpet and Accessories; FIO.

Three copies of carpet manufacturer's maintenance instructions describing recommended type of cleaning equipment and material, spotting and cleaning methods, and cleaning cycles.

## 1.3 REGULATORY REQUIREMENTS

Carpet and adhesives shall bear the Carpet and Rug Institute (CRI) Indoor Air Quality (IAQ) label. Carpet type bearing the label will indicate that the carpet has been tested and meets the criteria of the CRI IAQ Carpet Testing Program, and minimizes the impact on indoor air quality.

## 1.4 DELIVERY AND STORAGE

Materials shall be delivered to the site in the manufacturer's original wrappings and packages clearly labeled with the manufacturer's name, brand name, size, dye lot number, and related information. Materials shall be stored in a clean, dry, well ventilated area, protected from damage and soiling, and shall be maintained at a temperature above 16 degrees C for 2 days prior to installation.

## 1.5 ENVIRONMENTAL REQUIREMENTS

Areas in which carpeting is to be installed shall be maintained at a temperature above 16 degrees C for 2 days before installation, during installation, and for 2 days after installation. A minimum temperature of 13 degrees C shall be maintained thereafter for the duration of the contract. Traffic or movement of furniture or equipment in carpeted area shall not be permitted for 24 hours after installation. Other work which would damage the carpet shall be completed prior to installation of carpet.

## 1.6 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one-year period shall be provided.

## 1.7 EXTRA MATERIALS

Extra materials shall be provided in the amount of 10% for future maintenance use. Extra material shall be full width from the rolls.

## 2 PRODUCTS

## 2.1 CARPET TYPE A (BARRACKS)

Carpet shall be first quality; free of visual blemishes, streaks, poorly dyed areas, fuzzing of pile yarn, spots or stains, and other physical and manufacturing defects. Carpet materials and treatments shall be reasonably nonallergenic and free of other recognized health hazards. All grade carpets shall have a static control construction which gives adequate durability and performance.

## 2.1.1.1 Physical Characteristics

Carpet shall comply with the following:

- a. Carpet Construction: graphics loop.
- b. Type: Broadloom 3.6 m minimum usable carpet width.
- c. Pile Type: Level-loop.
- d. Pile Fiber: continuous filament nylon.
- e. Pile or Wire Height: Minimum 3.96 mm in accordance with ASTM D 418.
- f. Yarn Ply: Minimum 2 in accordance with ASTM D 1423.
- g. Gauge or Pitch: Minimum 2.54 mm (1/10 inch) in accordance with ASTM D 418.
- h. Stitches or Rows/Wires: Minimum 4.72 per cm (12 stitches/inch).
- i. Finished Pile Yarn Weight: Minimum 1.08 kg per square meter (32 oz./sq. yard). This does not include weight of backings. Weight shall be determined in accordance with ASTM D 418.
- j. Pile Density: Minimum 10,286.
- k. Dye Method: Solution dyed.
- l. Backing Materials: Primary backing material shall be polypropylene. Secondary backing material shall be polypropylene or shall be those customarily used and accepted by the trade for each type of carpet, except when a special unitary back designed for gluedown is provided.

## 2.1.1.2 Performance Requirements

- a. Static Control: Static control shall be provided to permanently control static buildup to less than 3.5 kV when tested at 20 percent relative humidity and 21 degrees C in accordance with AATCC TM-134.
- b. Flammability and Critical Radiant Flux Requirements: Carpet shall comply with 16 CFR 1630. Carpet in corridors and exits shall have a minimum average critical radiant flux of 0.22 watts per square centimeter when tested in accordance with ASTM E 648.
- c. Tuft Bind: Tuft bind force required to pull a tuft or loop free from carpet backing shall be a minimum 40 N average force for loop pile.
- d. Additional Performance Characteristics:
  - (1) Antimicrobial: Nontoxic antimicrobial treatment in accordance with AATCC TM-174, Part I (qualitative), guaranteed by the carpet manufacturer to last the life of the carpet.

- e. Colorfastness to Crocking: Dry and wet crocking shall comply with AATCC TM-165 and shall have a minimum rating of step 4 on the AATCC Color Transference Chart for all colors.
- f. Colorfastness to Light: Colorfastness to light shall comply with AATCC TM-16 and shall have a minimum 4 grey scale rating after 40 hours.
- g. Delamination Strength: Delamination strength for tufted carpet with a secondary back shall be minimum of 440 N/m.

## 2.2 CARPET TYPE B (COMMUNITY BUILDING - FIELD)

### 2.2.1 Physical Characteristics

Carpet shall comply with the following:

- a. Carpet Construction: graphics loop.
- b. Type: Broadloom 3.6 m minimum usable carpet width.
- c. Pile Type: Level-loop.
- d. Pile Fiber: continuous filament nylon.
- e. Pile or Wire Height: Minimum 3.96 mm in accordance with ASTM D 418.
- f. Yarn Ply: Minimum 2 in accordance with ASTM D 1423.
- g. Gauge or Pitch: Minimum 2.54 mm (1/10 inch) in accordance with ASTM D 418.
- h. Stitches or Rows/Wires: Minimum 4.72 per cm (12 stitches/inch).
- i. Finished Pile Yarn Weight: Minimum 1.08 kg per square meter (32 oz./sq. yard). This does not include weight of backings. Weight shall be determined in accordance with ASTM D 418.
- j. Pile Density: Minimum 10,286.
- k. Dye Method: Solution dyed.
- l. Backing Materials: Primary backing material shall be polypropylene. Secondary backing material shall be polypropylene or shall be those customarily used and accepted by the trade for each type of carpet, except when a special unitary back designed for gluedown is provided.

### 2.2.2 Performance Requirements

- a. Static Control: Static control shall be provided to permanently control static buildup to less than 3.5 kV when tested at 20 percent relative humidity and 21 degrees C in accordance with AATCC TM-134.

- b. Flammability and Critical Radiant Flux Requirements: Carpet shall comply with 16 CFR 1630. Carpet in corridors and exits shall have a minimum average critical radiant flux of 0.22 watts per square centimeter when tested in accordance with ASTM E 648.
- c. Tuft Bind: Tuft bind force required to pull a tuft or loop free from carpet backing shall be a minimum 40 N average force for loop pile.
- d. Additional Performance Characteristics:
  - (1) Antimicrobial: Nontoxic antimicrobial treatment in accordance with AATCC TM-174, Part I (qualitative), guaranteed by the carpet manufacturer to last the life of the carpet.
- e. Colorfastness to Crocking: Dry and wet crocking shall comply with AATCC TM-165 and shall have a minimum rating of step 4 on the AATCC Color Transference Chart for all colors.
- f. Colorfastness to Light: Colorfastness to light shall comply with AATCC TM-16 and shall have a minimum 4 grey scale rating after 40 hours.
- g. Delamination Strength: Delamination strength for tufted carpet with a secondary back shall be minimum of 440 N/m.

## 2.3 CARPET TYPE C (COMMUNITY BUILDING - BORDER)

### 2.3.1 Physical Characteristics

Carpet shall comply with the following:

- a. Carpet Construction: cut pile.
- b. Type: Broadloom 3.6 m minimum usable carpet width.
- c. Pile Type: cut pile.
- d. Pile Fiber: 100% Monsanto LXI, type 6,6 nylon.
- e. Pile or Wire Height: Minimum 7.14 mm in accordance with ASTM D 418.
- f. Yarn Ply: Minimum 2 in accordance with ASTM D 1423.
- g. Gauge or Pitch: Minimum 2.54 mm (1/10 inch) in accordance with ASTM D 418.
- h. Stitches or Rows/Wires: Minimum 4.4 per cm (11.2 stitches/inch).
- i. Finished Pile Yarn Weight: Minimum 1.21 kg per square meter (36 oz./sq. yard). This does not include weight of backings. Weight shall be determined in accordance with ASTM D 418.
- j. Pile Density: Minimum 6085.
- k. Dye Method: Piece dyed.

1. Backing Materials: Primary backing material shall be polypropylene. Secondary backing material shall be polypropylene or shall be those customarily used and accepted by the trade for each type of carpet, except when a special unitary back designed for gluedown is provided.

#### 2.3.2 Performance Requirements

- a. Static Control: Static control shall be provided to permanently control static buildup to less than 3.5 kV when tested at 20 percent relative humidity and 21 degrees C in accordance with AATCC TM-134.
- b. Flammability and Critical Radiant Flux Requirements: Carpet shall comply with 16 CFR 1630. Carpet in corridors and exits shall have a minimum average critical radiant flux of 0.22 watts per square centimeter when tested in accordance with ASTM E 648.
- c. Tuft Bind: Tuft bind force required to pull a tuft or loop free from carpet backing shall be a minimum 40 N average force for loop pile.
- d. Additional Performance Characteristics:
  - (1) Antimicrobial: Nontoxic antimicrobial treatment in accordance with AATCC TM-174, Part I (qualitative), guaranteed by the carpet manufacturer to last the life of the carpet.
- e. Colorfastness to Crocking: Dry and wet crocking shall comply with AATCC TM-165 and shall have a minimum rating of step 4 on the AATCC Color Transference Chart for all colors.
- f. Colorfastness to Light: Colorfastness to light shall comply with AATCC TM-16 and shall have a minimum 4 grey scale rating after 40 hours.
- g. Delamination Strength: Delamination strength for tufted carpet with a secondary back shall be minimum of 440 N/m.

#### 2.4 CARPET CUSHION (BARRACKS ONLY)

Carpet cushion shall be first quality, free of blemishes and other physical and manufacturing defects. Cushion materials and treatments shall be reasonably nonallergenic, nontoxic, free of other recognized health hazards, and shall conform to the following:

##### 2.4.1 Rubber Carpet Cushion

Rubber cushion shall comply with FS ZZ-C-00811, Type I, Class 1, flat or rippled 1/4 inch thick.

##### 2.4.2 Urethane Carpet Cushion

Urethane prime or densified prime cushion shall comply with FS L-C-001676, Class 1, 3/8 inch thick. Urethane bonded cushion shall comply with FS L-C-001369, Class 1, 3/8 inch thick.



## 2.5 ADHESIVES AND CONCRETE PRIMER

Adhesives and concrete primers for installation of carpet shall be waterproof, nonflammable, meet local air-quality standards, and shall be as recommended by the carpet manufacturer. Seam adhesive shall be waterproof, nonflammable, and nonstaining as recommended by the carpet manufacturer. Release adhesive for modular tile carpet shall be as recommended by the carpet manufacturer. Adhesives flashpoint shall be minimum 60 degrees C in accordance with ASTM D 3278.

## 2.6 MOLDING

Vinyl molding shall be heavy-duty and designed for the type of carpet being installed. Floor flange shall be a minimum 50 mm wide. Color shall be compatible with carpet color.

## 2.7 TAPE

Tape for seams shall be as recommended by the carpet manufacturer for the type of seam used in installation.

## 2.8 COLOR, TEXTURE, AND PATTERN

Color, texture, and pattern shall be [in accordance with Section 09915 COLOR SCHEDULE.

## 3 EXECUTION

### 3.1 SURFACE PREPARATION

Carpet shall not be installed on surfaces that are unsuitable and will prevent a proper installation. Holes, cracks, depressions, or rough areas shall be repaired using material recommended by the carpet or adhesive manufacturer. Floor shall be free of any foreign materials and swept broom clean. Before beginning work, subfloor shall be tested with glue and carpet to determine "open time" and bond.

### 3.2 MOISTURE AND ALKALINITY TEST

Concrete slab shall be tested for moisture content and excessive alkalinity in accordance with CRI 104. The moisture content shall not exceed a hygrometer reading of 65 percent.

### 3.3 PREPARATION OF CONCRETE SUBFLOOR

Installation of the carpeting shall not commence until concrete substrate is at least 90 days old. The concrete surfaces shall be prepared in accordance with instructions of the carpet manufacturer. Type of concrete sealer, when required, shall be compatible with the carpet.

### 3.4 INSTALLATION

Installation shall be in accordance with the manufacturer's instructions and CRI 104. Edges of carpet meeting hard surface flooring shall be protected with molding. Installation shall be in accordance with the molding manufacturer's instructions.

### 3.4.1 Broadloom Installation

Broadloom carpet shall be installed stretch-in tackless over cushion and shall be smooth, uniform and secure, with a minimum of seams. Broadloom carpet without cushion shall be direct glue down and shall be smooth, uniform, and secure, with a minimum of seams. Seams shall be uniform, unnoticeable, and treated with a seam adhesive. Side seams shall be run toward the light where practical and where such layout does not increase the number of seams. Breadths shall be installed parallel, with carpet pile in the same direction. Patterns shall be accurately matched. Cutouts, as at door jambs, columns and ducts shall be neatly cut and fitted securely. Seams at doorways shall be located parallel to and centered directly under doors. Seams shall not be made perpendicular to doors or at pivot points. Seams at changes in directions of corridors shall follow the wall line parallel to the carpet direction. Corridors with widths less than 1.8 m shall have the carpet laid lengthwise down the corridors.

## 3.5 CLEANING AND PROTECTION

### 3.5.1 Cleaning

After installation of the carpet, debris, scraps, and other foreign matter shall be removed. Soiled spots and adhesive shall be removed from the face of the carpet with appropriate spot remover. Protruding face yarn shall be cut off and removed. Carpet shall be vacuumed clean.

### 3.5.2 Protection

The installed carpet shall be protected from soiling and damage with heavy, reinforced, nonstaining kraft paper, plywood, or hardboard sheets. Edges of kraft paper protection shall be lapped and secured to provide a continuous cover. Traffic shall be restricted for at least 45 hours. Protective covering shall be removed when directed by the Contracting Officer.

## 3.6 REMNANTS

Remnants remaining from the installation, consisting of scrap pieces more than 600 mm in dimension with more than 0.6 square meters total, shall be provided. Non-retained scraps shall be removed from site.

## SECTION 09840

## ACOUSTICAL WALL TREATMENT

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS (AATCC)

AATCC TM-16 (1993) Test Method: Colorfastness to Light

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 423 (1990a) Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method

ASTM E 84 (1996a) Surface Burning Characteristics of Building Materials

## INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS (ICBO)

ICBO-01 (1997) Uniform Building Code (3 Vol)

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

## SD-01 Data

Acoustical Wall Panels; FIO.

Manufacturer's descriptive data and catalog cuts.

## SD-04 Drawings

Acoustical Wall Panels; FIO.

Drawings showing plan locations, elevations and details. Drawings shall include details of method of anchorage, location of doors and other openings, base detail and shape and thickness of materials.

## SD-06 Instructions

Acoustical Wall Panels; FIO.

Manufacturer's installation instructions and recommended cleaning instructions.

## SD-13 Certificates

Acoustical Wall Panels; FIO.

Certificates of compliance from an independent laboratory accredited by the National Laboratory Accreditation Program of the National Institute of Standards. A label or listing from the testing laboratory will be acceptable evidence of compliance.

## SD-14 Samples

Acoustical Wall Panels; GA.

Manufacturer's standard fabric swatches, minimum 450 mm wide by 600 mm long; 2 samples of each color range specified.

## 1.3 DELIVERY AND STORAGE

Materials delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt, dust, or other contaminants.

## 1.4 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one year period shall be provided.

## 2 PRODUCTS

## 2.1 FABRIC COVERED ACOUSTICAL WALL PANELS

Acoustical wall panels shall consist of prefinished factory assembled, seamless fabric covered, fiber glass or mineral fiber core system as described below. Wall panels shall be manufactured to the dimensions and configurations shown on the drawings. Perimeter edges shall be reinforced by either an aluminum frame or a formulated resin edge hardener. Acoustical wall panels installed in non-sprinklered areas must comply with the requirements of ICBO-01, Standard 42-2.

- a. Panel Width: Panel width shall be as detailed.
- b. Panel Height: Panel height shall be as detailed.
- c. Thickness: Panel thickness shall be as required to meet the indicated NRC range.
- d. Fabric Covering: perforated vinyl covering with fabric backing, minimum 0.62 kg per linear meter total weight. Fabric covering shall be stretched free of wrinkles and then bonded to the edges and back or bonded directly to the panel face, edges, and back of panel a minimum distance standard with the manufacturer. Light fastness (fadeometer) shall be approximately 40 hours in accordance with AATCC TM-16.
- e. Fire rating for the complete composite system: Class A, 200 or less smoke density and flame spread less than 25, when tested in accordance with ASTM E 84.

- f. Substrate: mineral fiber.
- g. Noise Reduction Coefficient (NRC) Range: 0.50 as per ASTM C 423.
- h. Edge Detail: Square edge.
- i. Core Type: Standard acoustical core.
- J. Mounting: Acoustical panels shall be mounted by manufacturer's standard adhesive mounting.
- k. Color: Color shall be in accordance with Section 09915 COLOR SCHEDULE.

### 3 EXECUTION

#### 3.1 SURFACE CONDITIONS

Walls shall be clean, smooth, oil free and prepared in accordance with panel manufacturer's instructions. Installation shall not begin until all wet work, such as, plastering, painting, and concrete are completely dry.

#### 3.2 INSTALLATION

Panel installation shall be by personnel familiar with and normally engaged in installation of acoustical wall panels. Panels shall be applied in accordance with the manufacturer's installation instructions.

#### 3.3 CLEANING

Following installation, dirty or stained panel surfaces shall be cleaned in accordance with manufacturer's instructions and left free from defects. Panels that are damaged, discolored, or improperly installed shall be removed and new panels provided as directed.

## SECTION 09900

## PAINTING, GENERAL

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

ACGIH-02	(1996) Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices
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## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 3273	(1994) Resistance to Growth of Mold on the Surface of Interior Coating in an Environmental Chamber
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ASTM D 3274	(1995) Evaluating Degree of Surface Disfigurement of Paint Films by Microbial (Fungal or Algal) Growth or Soil and Dirt Accumulation
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ASTM D 4214	(1989) Evaluating the Degree of Chalking of Exterior Paint Films
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## STEEL STRUCTURES PAINTING COUNCIL (SSPC)

SSPC SP 1	(1982) Solvent Cleaning
SSPC SP 2	(1995) Hand Tool Cleaning
SSPC SP 3	(1995) Power Tool Cleaning
SSPC SP 7	(1994) Brush-Off Blast Cleaning

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

SD-01 Data

Paint; FIO.

The names, quantity represented, and intended use for the proprietary brands of materials proposed to be substituted for the specified materials .

## SD-06 Instructions

Mixing and Thinning; FIO.

Application; FIO.

Manufacturer's current printed product description, material safety data sheets (MSDS) and technical data sheets for each coating system. Detailed mixing, thinning and application instructions, minimum and maximum application temperature, and curing and drying times between coats for epoxy, moisture-curing polyurethane, and liquid glaze coatings. Detailed application instructions for textured coatings shall be provided.

## SD-09 Reports

Paint; FIO.

A statement as to the quantity represented and the intended use, plus the following test report for batches in excess of 200 L:

- a. a report of test results for properties of weight per liter, viscosity, fineness of grind, drying time, color, and gloss.

## SD-13 Certificates

Lead; FIO.

Mildewcide and Insecticide; FIO.

Volatile Organic Compound (VOC) Content; FIO.

Certificate stating that paints for interior use contain no mercurial mildewcide or insecticide. Certificate stating that paints proposed for use contain not more than 0.06 percent lead. Certificate stating that paints proposed for use meet the VOC regulations of the local Air Pollution Control Districts having jurisdiction over the geographical area in which the project is located.

## SD-14 Samples

Paint; FIO.

While the material is at the site or source of supply, and at a time agreeable to the Contractor and the Contracting Officer, a 1 liter sample of each color and batch, except for quantities of 200 liters or less, shall be taken by random selection from the sealed containers by the Contractor in the presence of a representative of the Contracting Officer. The contents of the containers to be sampled shall be thoroughly mixed to ensure that the sample is representative. Samples shall be identified by designated name, specification number, manufacturer name and address, batch number, project contract number, intended use, and quantity involved.

## 1.3 PACKAGING, LABELING, AND STORING

Paints shall be in sealed containers that legibly show the designated name, formula or specification number, batch number, color, quantity, date of manufacture, manufacturer's formulation number, manufacturer's directions including any warnings and special precautions, and name of manufacturer. Pigmented paints shall be furnished in containers not larger than 20 liters. Paints and thinner shall be stored in accordance with the manufacturer's

written directions and as a minimum stored off the ground, under cover, with sufficient ventilation to prevent the buildup of flammable vapors and at temperatures between 4 and 35 degrees C. Paints shall be stored on the project site or segregated at the source of supply sufficiently in advance of need to allow 30 days for testing.

#### 1.4 APPROVAL OF MATERIALS

When samples are tested, approval of materials will be based on tests of the samples; otherwise, materials will be approved based on test reports furnished with them. If materials are approved based on test reports furnished, samples will be retained by the Government for testing should the materials appear defective during or after application. In addition to any other remedies under the contract the cost of retesting defective materials will be at the Contractor's expense.

#### 1.5 ENVIRONMENTAL CONDITIONS

Unless otherwise recommended by the paint manufacturer, the ambient temperature shall be between 7 and 35 degrees C applying coatings other than water-thinned, epoxy, and moisture-curing polyurethane coatings. Water-thinned coatings shall be applied only when ambient temperature is between 10 and 32 degrees C. Epoxy, and moisture-curing polyurethane coatings shall be applied only within the minimum and maximum temperatures recommended by the coating manufacturer. Moisture-curing polyurethane shall not be applied when the relative humidity is below 30 percent.

#### 1.6 SAFETY AND HEALTH

Work shall comply with applicable Federal, State, and local laws and regulations, and with the ACCIDENT PREVENTION PLAN, including the Activity Hazard Analysis as specified in the CONTRACT CLAUSES. The Activity Hazard Analysis shall include analyses of the potential impact of painting operations on painting personnel and on others involved in and adjacent to the work zone.

##### 1.6.1 Worker Exposures

Exposure of workers to chemical substances shall not exceed limits as established by ACGIH-02, or as required by a more stringent applicable regulation.

##### 1.6.2 Toxic Compounds

Toxic compounds having ineffective physiological properties, such as odor or irritation levels, shall not be used unless approved by the Contracting Officer.

##### 1.6.3 Training

Workers having access to an affected work area shall be informed of the contents of the applicable material data safety sheets (MSDS) and shall be informed of potential health and safety hazard and protective controls associated with materials used on the project. An affected work area is one which may receive mists and odors from the painting operations. Workers involved in preparation, painting and clean-up shall be trained in the safe handling and application, and the exposure limit, for each material which



the worker will use in the project. Personnel having a need to use respirators and masks shall be instructed in the use and maintenance of such equipment.

#### 1.6.4 Coordination

Work shall be coordinated to minimize exposure of building occupants, other Contractor personnel, and visitors to mists and odors from preparation, painting and clean-up operations.

## 2 PRODUCTS

### 2.1 PAINT

The term "paint" as used herein includes emulsions, enamels, paints, stains, varnishes, sealers, cement-emulsion filler, and other coatings, whether used as prime, intermediate, or finish coat. Paint shall conform to the respective specifications listed for use in the painting schedules at the end of this section, except when the required amount of a material of a particular batch is 200 liters or less, an approved first-line proprietary paint material with similar intended usage and color to that specified may be used. Additional requirements are as follows:

#### 2.1.1 Colors and Tints

Colors shall be as selected from manufacturer's standard colors, as indicated. Manufacturer's standard color is for identification of color only. Tinting of epoxy, and urethane, paints shall be done by the manufacturer. Stains shall conform in shade to manufacturer's standard color. The color of the undercoats shall vary slightly from the color of the next coat.

#### 2.1.2 Mildewcide and Insecticide

Paint specified for all coats applied to fabrics and vapor barrier jackets over insulation shall contain a mildewcide that will not adversely affect the color, texture, or durability of the coating. The mildewcide shall be incorporated into the paint by the manufacturer and shall attain a surface disfigurement rating of 8 or greater when tested in accordance with ASTM D 3273 and evaluated in accordance with ASTM D 3274. Mercurial mildewcide shall not be used in interior paint. Insecticides shall not be used in paint.

#### 2.1.3 Lead

Paints containing lead in excess of 0.06 percent by weight of the total nonvolatile content (calculated as lead metal) shall not be used.

#### 2.1.4 Chromium

Paints containing zinc chromate or strontium chromate pigments shall not be used.

### 2.1.5 Volatile Organic Compound (VOC) Content

Paints shall comply with applicable state and local laws enacted to insure compliance with Federal Clean Air Standards and shall conform to the restrictions of the local air pollution control authority.

## 3 EXECUTION

### 3.1 PROTECTION OF AREAS NOT TO BE PAINTED

Items not to be painted which are in contact with or adjacent to painted surfaces shall be removed or protected prior to surface preparation and painting operations. Items removed prior to painting shall be replaced when painting is completed. Following completion of painting, workmen skilled in the trades involved shall reinstall removed items. Surfaces contaminated by coating materials shall be restored to original condition.

### 3.2 SURFACE PREPARATION

Surfaces to be painted shall be clean and free of foreign matter before application of paint or surface treatments. Oil and grease shall be removed with clean cloths and cleaning solvents prior to mechanical cleaning. Cleaning solvents shall be of low toxicity with a flashpoint in excess of 38 degrees C. Cleaning shall be programmed so that dust and other contaminants will not fall on wet, newly painted surfaces. Exposed ferrous metals such as nail heads on or in contact with surfaces to be painted with water-thinned paints, shall be spot-primed with a suitable corrosion-inhibitive primer capable of preventing flash rusting and compatible with the coating specified for the adjacent areas.

#### 3.2.1 Concrete, Stucco and Masonry Surfaces

Concrete, stucco and masonry surfaces shall be allowed to dry at least 30 days before painting, except concrete slab on grade which shall be allowed to cure 90 days before painting. Glaze, efflorescence, laitance, dirt, grease, oil, asphalt, surface deposits of free iron and other foreign matter shall be removed prior to painting. Surfaces to receive polyurethane, chlorinated rubber or epoxy coatings shall be acid-etched or mechanically abraded as specified by the coating manufacturer, rinsed with water, allowed to dry, and treated with the manufacturer's recommended conditioner prior to application of the first coat.

#### 3.2.2 Ferrous Surfaces

Ferrous surfaces including those that have been shop-coated, shall be solvent-cleaned. Surfaces that contain loose rust, loose mill scale, and other foreign substances shall be cleaned mechanically with hand tools according to SSPC SP 2, power tools according to SSPC SP 3 or by sandblasting according to SSPC SP 7. Shop-coated ferrous surfaces shall be protected from corrosion by treating and touching up corroded areas immediately upon detection.

#### 3.2.3 Nonferrous Metallic Surfaces

Galvanized, aluminum and aluminum-alloy, lead, copper, and other nonferrous metal surfaces shall be solvent-cleaned in accordance with SSPC SP 1.

#### 3.2.4 Gypsum Board Surfaces

Gypsum board surfaces shall be dry and shall have all loose dirt and dust removed by brushing with a soft brush, rubbing with a cloth, or vacuum-cleaning prior to application of the first-coat material. A damp cloth or sponge may be used if paint will be water-based.

#### 3.2.5 Mastic-Type Surfaces

Mastic-type surfaces shall be prepared by removing foreign material.

#### 3.2.6 Plaster Surfaces

Plaster shall age at least 30 days before painting. Plaster shall be clean and free from loose matter and shall have an instrument-measured moisture content not exceeding 8 percent.

#### 3.2.7 Wood Surfaces

Wood surfaces shall be cleaned of foreign matter. Wood surfaces adjacent to surfaces to receive water-thinned paints shall be primed and/or touched up before applying water-thinned paints. Small, dry seasoned knots shall be scraped, cleaned, and given a thin coat of commercial knot sealer, before application of the priming coat. Pitch on large, open, unseasoned knots and all other beads or streaks of pitch shall be scraped off, or, if it is still soft, removed with mineral spirits or turpentine, and the resinous area shall be thinly coated with knot sealer. Finishing nails shall be set, and all holes and surface imperfections shall be primed. After priming, holes and imperfections in finish surfaces shall be filled with putty or plastic wood filler, colored to match the finish coat if natural finish is required, allowed to dry, and sanded smooth. Putty or wood filler shall be compatible with subsequent coatings. Interior wood surfaces to receive stain shall be sanded. Oak and other open-grain wood to receive stain shall be given a coat of wood filler not less than 8 hours before the application of stain; excess filler shall be removed and the surface sanded smooth. Floors of oak or similar open-grain wood shall be filled with wood filler recommended by the finish manufacturer and the excess filler removed. Moisture content of the wood shall not exceed 12 percent as measured by a moisture meter, unless otherwise authorized.

#### 3.2.8 Previously Painted Surfaces

Previously painted surfaces damaged during construction shall be thoroughly cleaned of all grease, dirt, dust or other foreign matter. Blistering, cracking, flaking and peeling or other deteriorated coatings shall be removed. Slick surfaces shall be roughened. Damaged areas such as, but not limited to, nail holes, cracks, chips, and spalls shall be repaired with suitable material to match adjacent undamaged areas. Edges of chipped paint shall be feather edged and sanded smooth. Rusty metal surfaces shall be cleaned as per SSPC requirements. Solvent, mechanical, or chemical cleaning methods shall be used to provide surfaces suitable for painting. Chalk shall be removed so that when tested in accordance with ASTM D 4214, the chalk resistance rating is no less than 8. New, proposed coatings shall be compatible with existing coatings. If existing surfaces are glossy, the gloss shall be reduced.

### 3.3 MIXING AND THINNING

When thinning is approved as necessary to suit surface, temperature, weather conditions, or application methods, paints may be thinned in accordance with the manufacturer's directions. When thinning is allowed, paints shall be thinned immediately prior to application with not more than 0.5 L of suitable thinner per liter. The use of thinner shall not relieve the Contractor from obtaining complete hiding, full film thickness, or required gloss. Thinning shall not cause the paint to exceed local limits on volatile organic compounds. Paints of different manufacturers shall not be mixed.

#### 3.3.1 Two-Component Systems

Two-component systems shall be mixed in accordance with manufacturer's instructions. Any thinning of the first coat to ensure proper penetration and sealing shall be as recommended by the manufacturer for each type of substrate.

### 3.4 APPLICATION

Painting practices shall comply with applicable state and local laws enacted to insure compliance with Federal Clean Air Standards. Unless otherwise specified or recommended by the paint manufacturer, paint may be applied by brush, roller, or spray. At the time of application, paint shall show no signs of deterioration. Uniform suspension of pigments shall be maintained during application. Each coat of paint shall be applied so dry film shall be of uniform thickness and free from runs, drops, ridges, waves, pinholes or other voids, laps, brush marks, and variations in color, texture, and finish. Hiding shall be complete. Rollers for applying paints and enamels shall be of a type designed for the coating to be applied and the surface to be coated. Special attention shall be given to insure that all edges, corners, crevices, welds, and rivets receive a film thickness equal to that of adjacent painted surfaces. Paints, except water-thinned types, shall be applied only to surfaces that are completely free of moisture as determined by sight or touch.

#### 3.4.1 Ventilation

Affected areas shall be ventilated during paint application so that workers exposure to chemical substances shall not exceed limits as established by ACGIH-02, or as required by a more stringent applicable regulation. Interior work zones having a volume of 280 cubic meters or less shall be ventilated at a minimum of 2 air exchanges per hour. Ventilation in larger work zones shall be maintained by means of mechanical exhaust. Solvent vapors shall be exhausted outdoors, away from air intakes and workers. Return air inlets in the work zone shall be temporarily sealed before start of work until the coatings have dried.

#### 3.4.2 Respirators

Operators and personnel in the vicinity of operating paint sprayers shall wear respirators.

### 3.4.3 First Coat

The first coat on plaster, gypsum wallboard, and other surfaces shall include repeated touching up of suction spots or overall application of primer or sealer to produce uniform color and gloss. Excess sealer shall be wiped off after each application. The first coat on both faces of wood doors shall be applied at essentially the same time. Glazed doors and sashes shall be given the specified coating system within 3 weeks of the time they are glazed, but not before the glazing material has set; paint shall overlay glass about 1.78mm all around. Each varnish coat shall be sanded lightly prior to application of subsequent coats.

### 3.4.4 Timing

Surfaces that have been cleaned, pretreated, and otherwise prepared for painting shall be given a coat of the specified first coat as soon as practical after such pretreatment has been completed, but prior to any deterioration of the prepared surface. Sufficient time shall elapse between successive coats to permit proper drying. This period shall be modified as necessary to suit weather conditions. Oil-based or oleoresinous solvent-type paints shall be considered dry for recoating when the paint feels firm, does not deform or feel sticky under moderate pressure of the thumb, and the application of another coat of paint does not cause the undercoat to lift or lose adhesion. Manufacturer's instructions for application, curing and drying time between coats of two-component systems shall be followed.

### 3.4.5 Stains

On smooth exterior wood surfaces such as the planed face of bevel siding, the stain shall be applied at a spreading rate of 9.8 to 12.3 square meters per liter. On rough surfaces such as an unplanned or scarred face of bevel siding, the stain shall be spread at the rate of 4.9 to 6.1 square meters per liter or as recommended by the manufacturer. Oil-type stain shall be applied by brushing with the grain for the full length of the board or course of siding.

### 3.4.6 Fillers

Concrete and masonry surface voids shall be filled; however, surface irregularities need not be completely filled. The dried filler shall be uniform and free of pinholes. Filler shall not be applied over caulking compound.

#### 3.4.6.1 Solvent-Thinned Filler

Solvent-thinned filler shall be applied to dry surfaces only and may be applied by brush or roller. Filler shall be allowed to set for 3 to 5 minutes or until the filler becomes tacky, and the excess material shall then be removed with a rubber squeegee. Surface voids shall be filled; however, surface irregularities need not be completely filled.

#### 3.4.6.2 Latex Filler

Latex filler shall be applied according to the manufacturer's instructions. Surface voids shall be filled and the filler allowed to dry the length of time specified by the manufacturer prior to applying successive coats of paint.

### 3.4.7 Textured Coating

Application of textured coating shall be as specified in the manufacturer's printed directions at a rate of 1.1 to 1.3 square meters per liter in one coat.

### 3.4.8 Ferrous-Metal Primer

Primer for ferrous-metal shall be applied to ferrous surfaces to receive paint other than asphalt varnish prior to deterioration of the prepared surface. The semitransparent film applied to some pipes and tubing at the mill is not to be considered a shop coat, but shall be overcoated with the specified ferrous-metal primer prior to application of finish coats.

### 3.5 PIPE COLOR CODE MARKING

Pipes in exposed areas and in accessible pipe spaces shall be provided with color band and titles adjacent to all valves, except those provided at plumbing fixtures, at not more than 12 meter spacing on straight pipe runs, adjacent to change in direction, and on both sides where pipes pass through walls or floors. Color code marking shall be of the color listed in TABLE I and the size listed in TABLE II. The arrows shall be installed adjacent to each band to indicate the direction of flow in the pipe. The legends shall be printed in upper-case black letters as listed in TABLE I. Letter sizes shall be as listed in TABLE II. Marking shall be painted or applied using colored, pressure-sensitive adhesive markers of standard manufacture. Paint shall be as specified for insulated and uninsulated piping.

TABLE I. COLOR CODES FOR MARKING PIPE

Material	Band	Letters and Arrow*	Legend
Cold water (potable) WATER	Green	White	POTABLE
Fire protection water WATER	Red	White	FIRE PR.
Hot water (domestic)	Green	White	H.W.
Hot water recirculating (domestic)	Green	White	H.W.R.
High temp. water supply	Yellow	Black	H.T.W.S.
High temp. water return	Yellow	Black	H.T.W.R.
Boiler feed water	Yellow	Black	B.F.
Low temp. water supply (heating)	Yellow	Black	L.T.W.S.
Low temp. water return (heating)	Yellow	Black	L.T.W.R.
Condenser water supply	Green	White	COND. W.S.
Condenser water return	Green	White	COND. W.R.
Chilled water supply	Green	White	C.H.W.S.
Chilled water return	Green	White	C.H.W.R.
Treated water	Yellow	Black	TR. WATER
Chemical feed	Yellow	Black	CH. FEED
Compressed air	Yellow	Black	COMP. AIR
Natural gas	Blue	White	NAT. GAS
Freon	Blue	White	FREON
Fuel oil	Yellow	Black	FUEL OIL
Steam	Yellow	Black	STM.
Condensate	Yellow	Black	COND.

TABLE II. COLOR CODE MARKING SIZES

Outside Diameter of Pipe Covering (mm)	Width of Color Band (mm)	Arrow Length x Width (mm)	Size of Legend Letters and Numerals (mm)
Less than 38	200	200 x 57	13
38 to 60	200	200 x 57	19
60 to 150	300	200 x 57	31
200 to 225	600	300 x 110	63
Over 250	800	300 x 115	88

### 3.6 MISCELLANEOUS PAINTING

#### 3.6.1 Lettering

Lettering shall be provided as scheduled on the drawings, shall be block type, and shall be black enamel, finished with a protective coating of spar varnish. Samples shall be approved before application.

### 3.7 SURFACES TO BE PAINTED

Surfaces listed in the painting schedules at the end of this section, other than those listed in paragraph SURFACES NOT TO BE PAINTED, shall be painted as scheduled.

### 3.8 SURFACES NOT TO BE PAINTED

Surfaces in the following areas are not to be painted: areas as shown. In addition surfaces of hardware, fittings, and other factory finished items shall not be painted.

### 3.9 CLEANING

Cloths, cotton waste and other debris that might constitute a fire hazard shall be placed in closed metal containers and removed at the end of each day. Upon completion of the work, staging, scaffolding, and containers shall be removed from the site or destroyed in an approved manner. Paint and other deposits on adjacent surfaces shall be removed and the entire job left clean and acceptable.

### 3.10 PAINTING SCHEDULES

The following painting schedules identify the surfaces to be painted and prescribe the paint to be used and the number of coats of paint to be applied.

**PAINTING SCHEDULE****EXTERIOR SURFACES**

STUCCO (portland cement type)

1. Latex Systems

a. Flat Finish

1st Coat: S-W A-100 Flat Latex House & Trim, A6 Series

2nd Coat: S-W A-100 Flat Latex House & Trim, A6 Series  
(4 mils wet, 1.4 mils dry per coat)

CONCRETE MASONRY UNITS

1. Latex Systems

a. Flat Finish

1st Coat: S-W ProMar Interior/Exterior Block Filler, B25W25  
(75-125 sq.ft./gal.)

2nd Coat: S-W A-100 Flat Latex House & Trim, A6 Series

3rd Coat: S-W A-100 Flat Latex House & Trim, A6 Series  
(4 mils wet, 1.4 mils dry per coat)

CONCRETE FLOORS, PATIOS, PORCHES, STEPS & PLATFORMS

1. Alkyd System

a. Gloss Finish

1st Coat: S-W Concrete and Terrazzo Sealer, B44V22

2nd Coat: S-W Industrial Enamel, B54 Series

2nd Coat: S-W Industrial Enamel, B54 Series  
(4 mils wet, 2 mils dry per coat)

ALUMINUM, ALUMINUM-ALLOY, AND OTHER NON-FERROUS METAL (NON-GALVANIZED)

| 1. **Latex** Systems  
| a. Gloss Finish

| 1st Coat: **S-W DTM Gloss Acrylic Primer, B66W1**  
| (6 mils wet, 3 mils dry)  
| 2nd Coat: S-W SWP Gloss House & Trim, A2 Series  
| 3rd Coat: S-W SWP Gloss House & Trim, A2 Series  
(4 mils wet, 2 mils dry per coat)

GALVANIZED

1. Alkyd Systems

a. Gloss Finish

1st Coat: S-W Galvite Paint, B50W3  
(6 mils wet, 2 mils dry)

2nd Coat: S-W SWP Gloss House & Trim, A2 Series

3rd Coat: S-W SWP Gloss House & Trim, A2 Series  
(4 mils wet, 2 mils dry per coat)



FERROUS METAL (Misc. Iron, Ornamental Iron, Catwalks, Fire Escapes, Hydrants, Handrails, Ladders, Fences, Etc.)

1. Alkyd Systems
  - a. Gloss Finish

1st Coat: S-W Kem Kromik Metal Primer, B50 Series  
(8 mils wet, 3 mils dry)  
2nd Coat: S-W Industrial Enamel, B54 Series  
3rd Coat: S-W Industrial Enamel, B54 Series  
(4 mils wet, 2 mils dry per coat)

SHOP PRIMED METAL (SIDING, PANELS, ETC.)

1. Alkyd Systems
  - a. Gloss Finish

1st Coat: S-W SWP Gloss House & Trim, A2 Series  
2nd Coat: S-W SWP Gloss House & Trim, A2 Series  
(4 mils wet, 2 mils dry per coat)

METAL - (Structural Iron & Steel, Tanks, Water Towers, Sashes, Trim, Conductors, Doors, Ducts, Vents, Copper (Not Galvanized))

1. Alkyd Systems
  - a. Gloss Finish

1st Coat: S-W Kem Kromik Metal Primer, B50 Series  
(8 mils wet, 3 mils dry)  
2nd Coat: S-W SWP Gloss House & Trim, A2 Series  
3rd Coat: S-W SWP Gloss House & Trim, A2 Series  
(4 mils wet, 2 mils dry per coat)

WOOD - (Floors, Dadoes, Platforms)

1. Alkyd Systems
  - a. Gloss Finish

1st Coat: S-W Industrial Enamel, B54 Series  
2nd Coat: S-W Industrial Enamel, B54 Series  
(4 mils wet, 2 mils dry per coat)

WOOD - (Plywood)

1. Latex Systems
  - a. Flat Finish

1st Coat: S-W A-100 Exterior Latex Primer, B42W41  
(4 mils wet, 1.4 mils dry)  
(if Tannin Bleeding occurs, use A-100 Exterior Wood Primer, Y24W20)  
2nd Coat: S-W A-100 Flat Latex House & Trim, A6 Series  
3rd Coat: S-W A-100 Flat Latex House & Trim, A6 Series  
(4 mils wet, 1.4 mils dry per coat)

## WOOD - (Shingles, Shakes, Rough-Sawn Lumber)

## 1. Stain - Alkyd Systems

## a. Semi-Transparent

1st Coat: S-W Semi-Transparent Wood Preservative Stain, A14T5

2nd Coat: S-W Semi-Transparent Wood Preservative Stain, A14T5

1st Coat: S-W Solid Color Exterior Stain, A14 Series

2nd Coat: S-W Solid Color Exterior Stain, A14 Series

## WOOD (Siding, Trim, Shutters, Sashes, Doors, Misc. Wood, Hardboard (Bare or Factory Primed))

## 1. Latex Systems

## a. Flat Finish

1st Coat: S-W A-100 Exterior Latex Primer, B42W41

(4 mils wet, 1.4 mils dry)

(if Tannin Bleeding occurs, use A-100 Exterior Wood Primer, Y24W20)

2nd Coat: S-W A-100 Flat Latex House &amp; Trim, A6 Series

3rd Coat: S-W A-100 Flat Latex House &amp; Trim, A6 Series

(4 mils wet, 1.4 mils dry per coat)

## 2. Alkyd Systems

## a. Flat Finish

1st Coat: S-W A-100 Exterior Wood Primer, Y24W20

(4 mils wet, 2.2 mils dry)

2nd Coat: S-W ProMar Alkyd Flat Exterior Finish, B38 Series

3rd Coat: S-W ProMar Alkyd Flat Exterior Finish, B38 Series

(4 mils wet, 2 mils dry per coat)

## 3. Stain - Alkyd Systems

## a. Semi-Transparent

1st Coat: S-W Semi-Transparent Wood Preservative Stain, A14T5

2nd Coat: S-W Semi-Transparent Wood Preservative Stain, A14T5

## b. Solid Color

1st Coat: S-W Solid Color Exterior Stain, A14 Series

2nd Coat: S-W Solid Color Exterior Stain, A14 Series

**INTERIOR SURFACES**

## CONCRETE - (Walls &amp; Ceilings, Poured Concrete, Precast Concrete, Unglazed Brick, Cement Board)

## a. Eg-Shel Finish

1st Coat: S-W ProMar 200 Latex Wall Primer, B28W200

(4 mils wet, 1.2 mils dry)

2nd Coat: S-W ProMar 200 Latex Eg-Shel Enamel, B20W200

3rd Coat: S-W ProMar 200 Latex Eg-Shel Enamel, B20W200

(4 mils wet, 1.3 mils dry per coat)

## CONCRETE MASONRY UNITS

1. Latex Systems
  - a. Semi-Gloss Finish
    - 1st Coat: S-W ProMar Interior/Exterior Block Filler B25W25 (75-125 sq.ft./gal.)
    - 2nd Coat: S-W ProMar 200 Latex Semi-Gloss B31W200 Series
    - 3rd Coat: S-W ProMar 200 Latex Semi-Gloss B31W200 Series (4 mils wet, 1.5 mils dry per coat)

GALVANIZED (painted to match adjacent finish unless noted otherwise)

1. Latex Systems
  - a. Semi-Gloss Finish
    - 1st Coat: S-W ProMar 200 Latex Semi-Gloss B31W200 Series
    - 2nd Coat: S-W ProMar 200 Latex Semi-Gloss B31W200 Series (4 mils wet, 1.3 mils dry per coat)

METAL - (Ceilings - Structural Steel, Joists, Trusses, Beams)

1. Dryfall Waterborne Systems
  - a. Semi-Gloss Finish
    - 1st Coat: S-W DTM Acrylic Primer/Finish, B66W1 (6 mils wet, 3 mils dry)
    - 2nd Coat: S-W Waterborne Acrylic Dryfall, B42WW2 (7 mils wet, 3 mils dry)

WOOD - ( Walls, Ceilings, Doors, Trim, Cabinet Work, Counters, Partitions, Frames [Including hardboard, plywood, Sitka Spruce, Southern Pine, Douglas Fir, Cedar, Redwood, Lauan])

1. Alkyd Systems (shelving and miscellaneous trim)
  - a. Semi-Gloss Finish
    - 1st Coat: S-W Wall & Wood Primer, B49W2 (4 mils wet, 2 mils dry)
    - 2nd Coat: S-W ProMar 200 Alkyd Semi-Gloss B34W200 Series
    - 3rd Coat: S-W ProMar 200 Alkyd Semi-Gloss B34W200 Series (4 mils wet, 2 mils dry per coat)
2. Stained & Varnished (Clear Finish)
  - a. Open Grained Wood
    - 1st Coat: S-W Interior Oil Stain, A48 Series
    - 2nd Coat: S-W SHERWOOD Natural Filler, D70T1
    - 3rd Coat: S-W Oil Base Varnish, Gloss A66V91
    - 4th Coat: S-W Oil Base Varnish, Gloss or Satin A66 Series
  - b. Closed Grain Wood
    - 1st Coat: S-W Interior Oil Stain, A48 Series
    - 2nd Coat: S-W Oil Base Varnish, Gloss A66V91
    - 3rd Coat: S-W Oil Base Varnish, Gloss or Satin A66 Series

## K. GYPSUM WALLBOARD - (Walls and ceilings)

## 1. Latex Systems

## a. Eg-Shel Finish (walls)

1st Coat: S-W ProMar 200 Latex Wall Primer, B28W200  
(4 mils wet, 1.2 mils dry)

2nd Coat: S-W ProMar 200 Latex Eg-Shel, B20W200 Series

3rd Coat: S-W ProMar 200 Latex Eg-Shel, B20W200 Series  
(4 mils wet, 1.6 mils dry per coat)

## b. Flat Finish (ceilings)

1st Coat: S-W ProMar 200 Latex Flat Wall Paint, B30W200  
(4 mils wet, 1.4 mils dry)

2nd Coat: S-W ProMar 200 Latex Flat Wall Paint, B30W200

3rd Coat: S-W ProMar 200 Latex Flat Wall Paint, B30W200  
(4 mils wet, 1.4 mils dry per coat)

## CANVAS - (Wall Covering, Pipe Wrapping, Etc.)

## 1. Latex Systems

## a. Flat Finish

1st Coat: S-W ProMar 200 Latex Wall Primer, B28W200  
(4 mils wet, 1.2 mils dry)

2nd Coat: S-W ProMar 200 Latex Flat Wall Paint, B30W200  
(4 mils wet, 1.4 mils dry)

## PIPE IDENTIFICATION

## 1. Alkyd Systems

## a. Gloss Finish

1st Coat: S-W Kem Kromik Metal Primer, B50 Series  
(6 mils wet, 3 mils dry)

2nd Coat: S-W Industrial Enamel, B54 Series

3rd Coat: S-W Industrial Enamel, B54 Series  
(4 mils wet, 2 mils dry per coat)

## SECTION 09915

## COLOR SCHEDULE

## 1 GENERAL

## 1.1 GENERAL

This section covers only the color of the exterior and interior materials and products that are exposed to view in the finished construction. The word "color" as used herein includes surface color and pattern. Requirements for quality and method of installation are covered in other appropriate sections of the specifications. Specific locations where the various materials are required are shown on the drawings. Items not designated for color in this section may be specified in other sections. When color is not designated for items, the Contractor shall propose a color for approval.

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

## SD-14 Samples

Color board; GA.

Five (5) complete sets of color boards, 90 days after the Contractor is given Notice to proceed, complying with the following requirements:

- a. Color boards shall reflect all actual finish textures, patterns, and colors required for this contract.
- b. Materials shall be labeled with the finish type, manufacturer's name, pattern, and color reference.
- c. Samples shall be on size A4 (297 x 210 or 8-1/2 by 11 inch) boards with a maximum spread of size A1 (648 x 838 or 25-1/2 by 33 inches) for foldouts.
- d. Samples for this color board are required in addition to samples requested in other specification sections.
- e. Color boards shall be submitted to the Contracting Officer.

## 2 PRODUCTS

## 2.1 REFERENCE TO MANUFACTURER'S COLOR

Where color is shown as being specific to one manufacturer, an equivalent color by another manufacturer may be submitted for approval. Manufacturers and materials specified are not intended to limit the selection of equal colors from other manufacturers.

## 2.2 COLOR SCHEDULE - BARRACKS BUILDING

The color schedule lists the colors, patterns and textures required for exterior and interior finishes, including both factory applied and field applied colors.

### 2.2.1 Exterior Walls

Exterior wall colors shall apply to exterior wall surfaces including recesses at entrances and projecting vestibules. Conduit shall be painted to closely match the adjacent surface color. Wall color shall be provided to match the colors listed below.

- a. Brick Field: Acme, 630 'Alluvial Velour Modular' (PEP Blend 41).
- b. Brick Accent: Acme, 673 'Golden Sunset Velour Modular' (DTP Blend 105).
- c. Metal Wall Panels, Louvers @ roof, Hardware, and Associated Trim (at Ridge Vent): Shall match the Roof color - AEP Span, Kynar 500, 'Redwood'.
- d. EIFS (exterior insulation and finish system: Dryvit, #109 'Eggshell Cream', Swirl finish.
- e. Textured Cementitious Coating: Shall match the EIFS color.
- f. Louvers (@ walls - adjacent to doors/frames): prefinished to match dark bronze anodized color.
- g. Louvers (adjacent to EIFS or cementitious coating areas): prefinished to match EIFS color.

### 2.2.2 Exterior Trim

Exterior trim shall be provided to match the colors listed below.

- a. Aluminum Windows & Louvers: dark bronze anodized.
- b. Fascia, Soffits, Overhangs, Balconies, Downspouts, Gutters: Shall match the EIFS color.
- c. Handrail/guard rail paint: shall match the dark bronze anodized aluminum color.
- d. Signage Background color: shall match the Anodized Dark Bronze Aluminum color.
- e. Signage Message color: shall match the EIFS color.
- f. Flashings (@ roof): shall match the roof color.
- g. Hollow-metal doors and frames: painted to match dark bronze anodized color (SW 1021 'Hi Tech Black').
- h. Tinted glazing: light bronze, equal to PPG 'Solarbronze'.

- i. Gutter Protection System: Gutter Helmet, color to match roof system color.

### 2.2.3 Exterior Roof

Roof color shall apply to exterior roof surfaces including sheet metal flashings and copings, mechanical units, roof trim, pipes, conduits, electrical appurtenances, and similar items. Roof color shall be provided to match the colors listed below.

- a. Metal: AEP Span, Kynar 500, 'Redwood'.
- b. Miscellaneous items, within the roof system, which are not possible to be factory finished shall match the prefinished roof color.

### 2.2.4 Interior Floor Finishes

Flooring materials shall be provided to match the colors listed below.

- a. Carpet: Patcraft, Censored, 18407-152 'Blue Dot'.
- b. Sheet Vinyl: Mannington Commercial, 'Fine Fields', 10126 Silver White (Service Area & Lavatory).
- c. Ceramic Floor Tile Field: Dal Tile, DK-37 White Granite (50 x 50 - Bath).
- d. Ceramic Floor Tile 1 Accent: Dal Tile, DK-311 Ebony (25 x 25 - Bath).
- e. Ceramic Floor Tile 2 Accent: Dal Tile (unless noted), (25 x 25 - Bath).  
Scheme 1 - R12, 'Amethyst' (American Olean)  
Scheme 2 - DK-462 'Teal'  
Scheme 3 - DK-23 'Cobalt Blue'  
Scheme 4 - DK-156 'Brown Stone'
- f. Epoxy Grout (for ceramic tile): Hydroment, 96648 'Silver Bullet'.

### 2.2.5 Interior Base Finishes

Base materials shall be provided to match the colors listed below.

- a. Resilient Rubber Base and Edge Strips: (Living/Sleeping units only):  
Johnsonite,  
Scheme 1 - DC-85 'Burgundy'  
Scheme 2 - DC-59 'Heather Green'  
Scheme 3 - DC-92 'Blue Lagoon'  
Scheme 4 - DC-29 'Moon Rock'
- b. Resilient Rubber Base and Edge Strips (everywhere but Living/Sleeping units): Johnsonite, DC-48 'Grey'
- c. Ceramic Tile: American Olean, D35 'Raven' (50 x 50 - Bath)

### 2.2.6 Interior Wall Finishes

Interior wall color shall apply to the entire wall surface, including reveals, vertical furred spaces, grilles, diffusers, electrical and access

panels, and piping and conduit adjacent to wall surfaces unless otherwise specified. Items not specified in other paragraphs shall be painted to match adjacent wall surface. Wall materials shall be provided to match the colors listed below.

- a. Paint (furr-downs): Sherwin-William 1003, 'First Star'.
- b. Vinyl Wall Covering Above Chair Rail (Living/Sleeping units):  
Koroseal, 'Ceres'  
Scheme 1 - B321-20 'Magnolia'  
Scheme 2 - B321-73 'Blue Mist'  
Scheme 3 - B321-96 'Antimony'  
Scheme 4 - B321-16 'White Sand'
- c. Vinyl Wall Covering Below Chair Rail (Living/Sleeping): Koroseal, 'Ceres'  
Scheme 1 - B321-34 'Cocoa Beige'  
Scheme 2 - B321-85 'Jade'  
Scheme 3 - B321-74 'Country Stone'  
Scheme 4 - B321-19 'Light Quarry'
- d. Vinyl Wall Covering Full Wall in Lavatories and Service Areas:  
Koroseal, 'Ceres'  
Scheme 1 - B321-05 'Tern'  
Scheme 2 - "  
Scheme 3 - "  
Scheme 4 - "
- e. Sisal Wall Fabric in crown/border and at desk: Fibreworks wall covering,  
Scheme 1 - 389 (mauve)  
Scheme 2 - 418 (teal)  
Scheme 3 - 430 (blue)  
Scheme 4 - 386 (lt. silver)
- f. Ceramic Wall Tile Field: Dal Tile, D-400 'Mayan White' (108 x 108 - Bath)
- g. Ceramic Wall Tile Accent 1: American Olean, D35 'Raven' (50 x 50 - Bath).
- h. Ceramic Wall Tile Accent 2: Dal Tile (108 x 108 U.N.O. - Bath)  
Scheme 1 - D-57 'Grape'  
Scheme 2 - K-162 'Teal'  
Scheme 3 - D-69 'Denim'  
Scheme 4 - 2801 'Premier Almond' (76 x 76)
- i. Ceramic Wall Tile Accent 3: Dal Tile DK-325 'Marble' (25 x 25 - Bath).
- j. Ceramic Tile Grout: Hydroment, 96114 'Classic Bone'
- k. FRP (fiberglas reinforced polyester) panels: Marlite, P-145, 'Silver', embossed finish (Maid/Mud rooms).



### 2.2.7 Interior Ceiling Finishes

Ceiling colors shall apply to ceiling surfaces including soffits, furred down areas, grilles, diffusers, registers, and access panels. Ceiling color shall also apply to joist, underside of roof deck, and conduit and piping where joists and deck are exposed and required to be painted. Ceiling materials shall be provided to match the colors listed below.

- a. Texture and Finish: USG, Spray Texture with Spatter/Knockdown Finish.
- b. Paint: manufacturer's ceiling white.
- c. Ceiling tile: manufacturer's standard white.

### 2.2.8 Interior Trim

Interior trim shall be provided to match the colors listed below.

- a. H.M. Doors & Door Frames Paint: Sherwin-Williams 1003, 'First Star'.
- b. Aluminum windows, louvers: dark bronze anodized.
- c. Window Stools, solid surfacing: Avonite, 'Artica' (matte finish).
- d. Fire Extinguisher Cabinets: manufacturer's standard white.
- e. Wood Stain: Red Oak with a Sherwin-Williams lacquer 'Fruitwood', 50% dilution (wood doors, chair rail, cornice picture rail)
- f. Horizontal Blinds: Levolor, 34 'Brushed Aluminum'.

### 2.2.9 Interior Miscellaneous

Miscellaneous items shall be provided to match the colors listed below.

- a. Desk Worksurface solid surfacing: Avonite, 'Artica' (matte finish).
- b. Wood on Desk, Service Cabinet, Lavatory Cabinet vertical surfaces and Medicine Cabinet Door: red oak with Sherwin-Williams 'Fruitwood', 50% dilution.
- c. Wall Switch Handles and Standard Receptacle Bodies: White.
- d. Electrical Device Cover Plates and Panels: White.
- e. Closet Shelving Paint: Sherwin-Williams 1003, 'First Star'
- f. Countertops solid surfacing (Lavatory cabinet, Service Area cabinet): Avonite, 'Artica' (matte finish).
- g. Wall Corner Guards: Acrovyn 186 'Champagne'; locations as shown.
- h. Hardware for cabinets: '638' antique brass finish to match interior door hardware.
- i. Sink bowl (unless otherwise shown): Avonite Formstone, F1-4300 'Cameo' (matte finish).

## 2.3 COLOR SCHEDULE - COMMUNITY BUILDING

The color schedule lists the colors, patterns and textures required for exterior and interior finishes, including both factory applied and field applied colors.

### 2.3.1 Exterior Walls

Exterior wall colors shall apply to exterior wall surfaces including recesses at entrances and projecting vestibules. Conduit shall be painted to closely match the adjacent surface color. Wall color shall be provided to match the colors listed below.

- a. Brick Field: Acme, 630 Alluvial Velour Modular (PEP Blend 41).
- b. Brick Accent: Acme, 673 Golden Sunset Velour Modular (DTP Blend 105).
- c. Metal Wall Panels, Louvers @ roof, Hardware, and Associated Trim (at clerestory): shall match roof color.
- d. EIFS base color (exterior insulation and finish system): Dryvit, #109 'Eggshell Cream', swirl finish.
- e. Textured Cementitious Coating: Shall match the EIFS color.
- f. Louvers (@ walls - adjacent to doors/frames): prefinished to match dark bronze anodized color.
- g. Louvers (@ walls adjacent to EIFS/cementitious costing areas): prefinished to match EIFS color.
- h. EIFS accent color (exterior insulation and finish system): Dryvit, #511 'Sea Frost', swirl finish.

### 2.3.2 Exterior Trim

Exterior trim shall be provided to match the colors listed below.

- a. Aluminum Doors, Door Frames, Window frames, & Louvers, exterior clerestory frame: anodized dark bronze.
- b. Hollow Metal Doors & Door Frames Paint: shall match the anodized dark bronze color (SW 1021 'Hi Tech Black').
- c. Wood at screen wall gate/dumpster screen: Cuprinol, 'chestnut brown' (semi-solid oil-based stain).
- d. Fascia, Soffits, Downspouts, gutters: shall match the EIFS color.
- e. Flashings (@ roof): shall match the roof color.
- f. Metal at screen wall gate paint: shall match the dark bronze anodized color (SW 1021 'Hi Tech Black').
- g. Handrails and Guardrails: shall match the dark bronze anodized aluminum

color (SW 1021 'Hi Tech Black').

- h. Signage Background color: Shall match the dark bronze color.
- i. Signage Message color: shall match the EIFS color.
- j. Tinted glazing: light bronze, equal to PPG 'Solarbronze'.
- k. Tinted glazing (accent): medium green, equal to PPG 'Solex'.
- l. Gutter Protection System: Gutter Helmet, color to match roofing system color.

#### 2.3.3 Exterior Roof

Roof color shall apply to exterior roof surfaces including sheet metal flashings and copings, mechanical units, roof trim, pipes, conduits, electrical appurtenances, and similar items. Roof color shall be provided to match the colors listed below.

- a. Metal: AEP Span, Kynar 500, 'Redwood'.
- b. Miscellaneous items, within the roof system, which are not possible to be factory finished shall match the prefinished roof color.

#### 2.3.4 Interior Floor Finishes

Flooring materials shall be provided to match the colors listed below.

- a. Carpet: Patcraft, Censored, 18407-159 'Plain Brown Wrapper'.
- b. Carpet Border: Patcraft, New Jazz 36, 680-111 'Reprise'.
- c. Vinyl Composition Tile Field 1: Armstrong, Imperial Textures, 51858 'Sandrift White' (Vending, Phone, Seating, Kitchen, Corridor).
- d. Vinyl Composition Tile Accent 1: Armstrong, Imperial Textures, 51907 'Mocha', (Vending, Phone, Seating, Kitchen, Corridor).
- e. Vinyl Composition Tile Accent 2: - Armstrong, 51941 'Polar White' (Vending, Phone, Seating, Corridor).
- f. Ceramic Floor Tile Field: Dal Tile, DK-335 'Porcelain' (50 x 50).
- g. Ceramic Floor Tile Accent 1: Dal Tile, DK-36 'Moca' (50 x 50).
- h. Porcelain Tile Field: Crossville, A215 'Empress White' CS (Cross-Slate finish - 150 x 150) (Laundry, Vestibule).
- i. Porcelain Tile accent 1: Crossville, A233 'Sand Bisque' CS (Cross-Slate finish - 150 x 150) (Laundry, Vestibule).
- j. Recessed Entry Mat: Peditred, 9302 'Gray Fox'.
- k. Epoxy Grout (for ceramic tile): Hydroment, 373 'Mobe Pearl'.
- l. Epoxy Grout (for porcelain tile): Hydroment, 370 'Antique White'.

### 2.3.5 Interior Base Finishes

Base materials shall be provided to match the colors listed below.

- a. Resilient Rubber Base and Edge Strips (used with carpet only):  
Johnsonite Rubber, DC-26 'Purple Shadow'.
- b. Resilient Rubber Base and Edge Strips: Johnsonite Rubber, DC-22 Pearl  
(everywhere but with carpet).
- c. Ceramic Tile:  
Dal Tile, 2801 'Premier Almond' (76 x 76)  
Dal Tile, DK-325 'Marble' (25 x 25)  
(Toilets).
- d. Porcelain Tile: Crossville, to match porcelain tile accent 1 color  
(Cross-Slate finish), cove base.

### 2.3.6 Interior Wall Finishes

Interior wall color shall apply to the entire wall surface, including reveals, vertical furred spaces, grilles, diffusers, electrical and access panels, and piping and conduit adjacent to wall surfaces unless otherwise specified. Items not specified in other paragraphs shall be painted to match adjacent wall surface. Wall materials shall be provided to match the colors listed below.

- a. All Wall Paint (unless otherwise noted): Sherwin Williams, SW1130  
'Neutral Ground'.
- b. Vinyl Wall Covering: Koroseal, Mystic II, E321-08 'Duck'.
- c. Wainscot wall covering (below chair rail): Fibreworks, 419.
- d. Ceramic Wall Tile Field: Dal Tile, D-400 'Mayan White' (108 x 108 -  
Toilets, Kitchen).
- e. Ceramic Wall Tile Accent 1: Dal Tile, 2801 'Premier Almond' (76 x 76 -  
Toilets, Kitchen).
- f. Ceramic Wall Tile Accent 2: Dal Tile DK-325 'Marble' (25 x 25 -  
Toilets, Kitchen).
- g. Ceramic Wall Tile Accent 3: Dal Tile, DK-36 'Moca' (108 x 108 -  
Kitchen).
- h. Ceramic Tile Grout (Toilets): Hydroment 96114 'Classic Bone'.
- i. Ceramic Tile Grout, (Kitchen): Hydroment 96114 'Classic Bone'.
- j. Soffit paint in Toilets (furr-downs): SW 1024 'White Cliffs'.
- k. Soffit paint in Kitchen (furr-down): SW 1024 'White Cliffs'.

1. Soffit paint in Laundry (furr-down): SW 1024 'White Cliffs'.
- m. FRP (fiberglas reinforced polyester) panels: Marlite, P-140, 'Ivory', embossed finish (Mud Room).

#### 2.3.7 Interior Ceiling Finishes

Ceiling colors shall apply to ceiling surfaces including soffits, furred down areas, grilles, diffusers, registers, and access panels. Ceiling color shall also apply to joist, underside of roof deck, and conduit and piping where joists and deck are exposed and required to be painted. Ceiling materials shall be provided to match the colors listed below.

- a. Acoustical Tile and Grid: manufacturer's standard white.
- b. Paint: Manufacturer's Ceiling White.

#### 2.3.8 Interior Trim

Interior trim shall be provided to match the colors listed below.

- a. Hollow metal doors, door frames, window frames paint: Sherwin-Williams, SW 1130 'Neutral Ground'.
- b. Aluminum Windows, Doors and Door Frames: anodized dark bronze.
- c. Window Stools, solid surfacing: Avonite Formstone, F1-9105, 'Aspen' (matte finish).
- d. Fire Extinguisher Cabinets: manufacturer's standard white.
- e. Wood Stain: red oak with Sherwin-Williams 'Fruitwood', 50% dilution (wood doors, wood cabinets in Kitchen).
- f. Horizontal blinds for exterior windows: Levolor, 310 'Sand'.
- g. Horizontal blinds for interior windows: Levolor, 310 'Sand'.
- h. Clerestory window frame: PVF standard 'white'.

#### 2.3.9 Interior Miscellaneous

Miscellaneous items shall be provided to match the colors listed below.

- a. Toilet Partitions and Urinal Screen Solid Plastic: Santana, Poly-Granite HD, 733 'Onyx'.
- b. Vanity countertop: Avonite Formstone, F1-9105 'Aspen' (matte finish).
- c. Plastic Laminate (vanity cabinet front, laundry cabinet countertop): Wilsonart 4621-60 'White Nebula'.
- d. Signage Message Color (excluding handicapped signage): manufacturer's standard white.

- e. Signage Background Color (excluding handicapped signage): Shall match the rubber wall base color - SW 1069 'Santa Fe Trail' (representative color).
- f. Wall Switch Handles and Standard Receptacle Bodies: 'Ivory'.
- g. Electrical Device Cover Plates and Panels: 'Ivory'.
- h. Kitchen Cabinet/island solid surface countertops: Avonite Formstone, F1-9105 'Aspen' (matte finish).
- i. Telephone Enclosure solid surface counter: Avonite Formstone, F1-9105 'Aspen' (matte finish).
- j. Telephone Enclosure Acoustical Fabric: Armstrong Classic Vinyl, 'Shell' (for wrapped divider panel).
- k. Laundry Shelving Paint: Sherwin-Williams, SW 1071 'Executive Suite'.
- l. Wainscot/chair rail (as shown): Acrovyn, 929 'Oyster Gray'.
- m. Corner guards (as shown): Acrovyn, 929 'Oyster Gray'.
- n. Patterned glass (laundry windows, interior door glazing): Cesar Color, 'Chroma Fusion', CF3332 (squares).
- o. Hardware for cabinets: '644' bronze anodized finish to match interior door hardware.
- p. Sink bowl (unless otherwise shown): Avonite Formstone, F1-4300 'Cameo' (matte finish).

3 EXECUTION (NOT APPLICABLE)

## SECTION 09950

## WALLCOVERINGS

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 84	(1996a) Surface Burning Characteristics of Building Materials
ASTM F 793	(1993) Standard Classification of Wallcovering by Durability Characteristics

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

## SD-01 Data

Wallcovering and Accessories; FIO.

Manufacturer's descriptive data, documentation stating physical characteristics, flame resistance, mildew and germicidal characteristics.

## SD-06 Instructions

Installation; FIO.

Preprinted installation instructions for wallcovering and accessories.

Maintenance; FIO.

Preprinted cleaning and maintenance instructions for wallcovering and accessories.

## SD-13 Certificates

Wallcovering; FIO.

Manufacturer's statement attesting that the product furnished meets or exceeds specification requirements. The statement must; be dated after the award of the contract, state Contractor's name and address, name the project and location, and list the requirements being certified.

## SD-14 Samples

## Wallcovering and Accessories; GA.

Three samples of each indicated type, pattern, and color of wallcovering. Samples of wall covering shall be minimum 125 x 175 mm and of sufficient size to show pattern repeat. Three samples of each indicated type corner guard and wainscot cap.

## 1.3 DELIVERY AND STORAGE

Materials shall be delivered to the site in manufacturers original unopened containers labeled with manufacturers name, pattern, texture, size and related information. Materials shall be stored in accordance with the manufacturer's instructions in a clean dry ventilated area with temperature maintained above 16 degrees C for two days prior to installation.

## 1.4 ENVIRONMENTAL REQUIREMENTS

Areas to receive wallcovering shall be maintained at a temperature above 16 degrees C for 7 days before, during, and 7 days after application.

## 1.5 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one-year period shall be provided.

## 1.6 EXTRA MATERIALS

Extra material from the same dye lot consisting of 3.0 m of full-width wallcovering for each 30 linear meters (10%) of wallcovering installed shall be provided for maintenance.

## 2 PRODUCTS

## 2.1 WALLCOVERINGS

Wallcoverings shall be material designed specifically for the specified use. The wallcovering shall contain a non-mercury based mildewcide. The wallcovering shall be type made without the use of cadmium based stabilizers. Wallcovering shall have a Class A flame spread rating of 0-25 and smoke development rating of 0-50 when tested in accordance with ASTM E 84.

## 2.1.1 Vinyl Wallcovering

Vinyl wallcovering shall be a vinyl coated woven or nonwoven fabric with germicidal additives and shall conform to ASTM F 793, Category V Type II, (0.445 to 0.815 kg ) total weight per square meter.

## 2.2 SISAL WALL COVERING

Sisal wall fabric in crown/border, desk and wainscot areas, as shown, shall be 100% sisal yarn, boucle weave with 6 mm pile height and a weight of 2.03 kg/sq. meter.



### 2.3 WALL LINER

Wall liner shall be a non-woven polyester cellulose blend having a minimum weight of 0.125 kg/square meter and a total minimum thickness of 0.33 mm. Wall liner shall have a Class A flame spread rating of 0-25 and smoke development rating of 0-50 when tested in accordance with ASTM E 84.

### 2.4 CORNER GUARDS (BARRACKS/COMMUNITY BUILDINGS)

Corner guards shall be 13 mm thick minimum and shall cover 50 mm minimum each side of corner at right angles. Corner guards shall be vinyl from the same lot and color.

#### 2.4.1 Acceptable Manufacturer

Acrovyn SSM-20, or approved equal. Color as selected in Section 09915 - Color Schedule.

### 2.5 WAINSCOT CAP (COMMUNITY BUILDING)

Wainscot cap shall be vinyl approximately 50 mm high, feathered at bottom edge, with an approximate 5 mm exposed face on top edge, and grooved to receive the covering.

#### 2.5.1 Acceptable Manufacturer

Acrovyn FR-270, or approved equal. Color as selected in Section 09915 - Color Schedule.

### 2.6 PRIMER AND ADHESIVE

Primer and adhesive shall be of a type recommended by the wallcovering manufacturer and shall contain a non-mercury based mildewcide. Adhesive shall be strippable type. Adhesive to install cap shall be of a type recommended by the manufacturer of the wainscot cap.

### 2.7 COLOR, TEXTURE, AND PATTERN

Color, texture, and pattern shall be in accordance with Section 09915 COLOR SCHEDULE.

## 3 EXECUTION

### 3.1 EXAMINATION

Contractor shall inspect all areas and conditions under which wallcoverings are to be installed. Contractor shall notify in writing of any conditions detrimental to the proper and timely completion of the installation. Work will proceed only when conditions have been corrected and accepted by the installer.

### 3.2 SURFACE PREPARATION

Wallcovering shall not be applied to surfaces that are rough, that contain stains that will bleed through the wallcovering, or that are otherwise unsuitable for proper installation. Cracks and holes shall be filled and rough spots shall be sanded smooth. Surfaces to receive wallcovering shall

be thoroughly dry. Plaster surfaces shall age at least 30 days prior to installation of vinyl wallcoverings. Interior surfaces of exterior masonry walls shall be sealed to prevent moisture penetration, then primed with a wallcovering primer in accordance with the manufacturer's instructions. Moisture content of plaster, concrete, and masonry shall be tested with an electric moisture meter and reading shall be not more than 5 percent. Masonry walls shall have flush joints. Concrete and masonry walls shall be coated with a thin coat of joint compound or cement plaster as a substrate preparation. To promote adequate adhesion of wall lining over masonry walls, the walls shall be primed as recommended by the wall lining manufacturer. Surface of walls shall be primed as required by manufacturer's instructions to permit ultimate removal of wallcovering from the wall surface. Primer shall be allowed to completely dry before adhesive application.

### 3.3 INSTALLATION

#### 3.3.1 Wall Lining

Wall lining shall be installed over masonry walls that are to receive wallcovering. Lining shall be installed in accordance with the manufacturer's installation instructions. Lining shall be installed perpendicular to wallcovering to prevent overlapping of seams between lining and wallcovering.

#### 3.3.2 Vinyl and Fabric Wallcovering

Wallcovering shall be installed in accordance with the manufacturer's installation instructions. Glue and adhesive spillage shall be immediately removed from wallcovering face and seams with a remover recommended by the manufacturer. After the installation is complete, the fabric wallcovering shall be vacuumed with a ceiling to floor motion.

#### 3.3.3 Corner Guards and Wainscot Cap

Corner guards and wainscot cap shall be installed where shown on the drawings and in accordance with the manufacturer's printed instructions. Corner guards shall run from top of base to wainscot cap in a continuous length.

### 3.4 CLEAN-UP

Upon completion of the work, wallcovering shall be left clean and free of dirt or soiling. Surplus materials, rubbish, and debris resulting from the wallcovering installation shall be removed and area shall be left clean.

## SECTION 09986

## SANITARY WALL/CEILING PANELS

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 423 (1990a) Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method

ASTM E 84 (1996a) Standard Test Method for Surface Burning Characteristics of Building Materials

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

## SD-01 Data

Panels and Accessories; FIO.

Manufacturer's descriptive data.

## SD-06 Instructions

Installation; FIO.

Installation instructions for panels and accessories.

Maintenance; FIO.

Cleaning and maintenance instructions for panels and accessories.

## SD-14 Samples

Panels and Accessories; GA.

Three samples of each indicated type, pattern, and color of panels required. Samples of panels shall be minimum 100 mm by 100 mm. Three samples of each indicated type trim pieces required.

## 1.3 DELIVERY AND STORAGE

Materials shall be delivered to the building site in original unopened containers. Materials shall be stored in accordance with the manufacturer's

instructions in a clean dry area with temperature maintained above 16 degrees C.

#### 1.4 ENVIRONMENTAL REQUIREMENTS

Areas to receive wall covering shall be maintained at a temperature above 16 degrees C for 3 days before, during, and 3 days after application.

## 2 PRODUCTS

### 2.1 WALL/CEILING PANELS

Panels shall be manufacturer's standard material designed specifically for the specified use.

#### 2.1.1 Sanitary Wall Panels

Sanitary panels shall be a product manufactured from fiber reinforced polyester (FRP). Material shall be non-porous and be a minimum of 2.3 mm in thickness. Unless specified otherwise, pattern and color of panels shall be as specified in Section 09915 - COLOR SCHEDULE.

### 2.2 MOLDINGS AND TRIM

Moldings and trim shall be compatible with the panels and from the same manufacturer. Products shall include an integral base unit for use at the bottom of the wall, as well as other horizontal and vertical trim to seal and protect panel joints and intersections. Materials for molding and trim shall be extruded PVC. Panels shall have a Class A flame spread rating of 0-25 and smoke development rating of less than 450 when tested in accordance with ASTM E 84.

### 2.3 SEALANT

Sealant shall be silicone type as specified in Section 07900 - JOINT SEALING and shall be installed in accordance with the manufacturer's panel system directions.

### 2.4 ADHESIVE

Adhesive shall be nonflammable type and as recommended by the manufacturer of the panel system.

### 2.5 SUGGESTED MANUFACTURERS

Suggested manufacturers are:

Marlite FRP, textured one side.

Marlite  
Dover, OH 44622  
330-343-6621

Glasteel, TOS (textured one side).

Glasteel, Inc.  
830 Highway 57 East  
Collierville, TN 38017  
800-238-5546

'Structoglas', textured one side.

Sequentia, Inc.  
P.O. Box 360530  
Strongsville, OH 44136  
216-238-2400

### 3 EXECUTION

#### 3.1 SURFACE PREPARATION

Sanitary panels must be applied over a smooth, solid, flat substrate such as drywall or plaster. Panels shall not be applied to surfaces that are rough, that contain stains that will bleed through, or that are otherwise unsuitable for proper installation. Cracks and holes shall be filled and rough spots shall be sanded smooth. Surfaces to receive panels shall be thoroughly dry. Plaster surfaces shall age at least 30 days prior to installation of panels. Moisture content of plaster, concrete, and masonry shall be tested with an electric moisture meter and reading shall be not more than 5 percent. Masonry walls shall have flush joints. Masonry walls shall be coated with a thin coat of joint compound or cement plaster as a substrate preparation. To promote adequate adhesion over masonry walls, the walls shall be primed as recommended by the panel manufacturer.

#### 3.2 INSTALLATION

Panels and trim shall be installed in strict accordance with manufacturer's installation instructions. **Under no circumstances shall mechanical fasteners be used in the installation of panels - panels shall rely on adhesive alone.** All moldings and trim shall provide for a minimum 3 mm expansion space to insure allowance for normal movement. Moldings and trim shall be installed in all areas where panels are used and in accordance with the manufacturer's printed instructions. Molding and trim shall run from top of base to ceiling in a continuous length. Junctures at horizontal trim sections shall be constructed in a professional, workmanlike manner.

#### 3.3 CLEAN-UP

Upon completion of the work, installation shall be left clean and free of dirt or soiling and shall be cleaned in accordance with manufacturer's directions.

## SECTION 10160

## TOILET PARTITIONS

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## FEDERAL SPECIFICATIONS (FS)

FS RR-P-1352

(Rev C) Partitions, Toilet, Complete

## 1.2 SYSTEM DESCRIPTION

Toilet partition system, including toilet enclosures, room entrance screens, and urinal screens, shall be a complete and usable system of panels, hardware, and support components. The partition system shall be provided by a single manufacturer and shall be a standard product as shown in the most recent catalog data. The partition system shall be as shown.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

## SD-01 Data

Toilet Partition System; FIO.

Manufacturer's technical data and catalog cuts including installation and cleaning instructions.

## SD-04 Drawings

Toilet Partition System; FIO.

Drawings showing plans, elevations, details of construction, hardware, reinforcing, fittings, mountings, and anchorings.

## SD-14 Samples

Toilet Partition System; GA.

Manufacturer's standard color charts and color samples.

## 1.4 DELIVERY, STORAGE, AND HANDLING

Components shall be delivered to the jobsite in the manufacturer's original packaging with the brand, item identification, and project reference clearly marked. Components shall be stored in a dry location that is adequately

ventilated and free from dust, water, or other contaminants and shall have easy access for inspection and handling.

## 1.5 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period shall be provided.

## 2 PRODUCTS

### 2.1 TOILET ENCLOSURES

Toilet enclosures shall conform to FS RR-P-1352, Type I, Style A. Width, length and height of toilet enclosures shall be as shown. Finish surface of panels shall be solid plastic (polyethylene). Panels indicated to receive toilet paper holders or grab bars as specified in Section 10800 TOILET ACCESSORIES shall be reinforced for the reception of the items required. Grab bars shall withstand a bending stress, shear stress, shear force, and a tensile force induced by 1112 N. Grab bars shall not rotate within their fittings.

All toilet partition doors shall be provided with a combination door bumper/coat hook. Finish shall be highly resistant to alkalies and acids common to toilet environments.

### 2.2 ROOM ENTRANCE SCREENS

Room entrance screens shall conform to FS RR-P-1352, Type II, Style A. Finish surface of screens shall be solid plastic (polyethylene). Length and height of screens shall be as shown.

### 2.3 URINAL SCREENS

Urinal screens shall conform to FS RR-P-1352, Type III, Style A. Finish surface of screens shall be solid plastic (polyethylene). Width and height of urinal screens shall be as shown.

### 2.4 HARDWARE

Hardware for the toilet partition system shall conform to FS RR-P-1352 for the specified type and style of partitions. Hardware finish shall be highly resistant to alkalies, urine, and other common toilet room acids.

### 2.5 COLORS

Color of finishes for toilet partition system components shall be as specified in Section 09915 COLOR SCHEDULE.

## 3 EXECUTION

### 3.1 INSTALLATION

Toilet partitions shall be installed straight and plumb in accordance with approved manufacturer's instructions with horizontal lines level and rigidly anchored to the supporting construction. Where indicated, anchorage to walls shall be by through-bolting or toggle-bolting where the toggle-bolt would not be acceptable to view on the opposite side of the wall. Drilling

and cutting for installation of anchors shall be at locations that will be concealed in the finished work.

### 3.2 ADJUSTING AND CLEANING

Doors shall have a uniform vertical edge clearance of approximately 5 mm and shall rest open at approximately 30 degrees when unlatched. Baked enamel finish shall be touched up with the same color of paint that was used for the finish. Toilet partitions shall be cleaned in accordance with approved manufacturer's instructions and shall be protected from damage until accepted.



## SECTION 10440

## INTERIOR SIGNAGE

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z97.1 (1984) Safety Glazing Materials Used in Buildings

## FEDERAL SPECIFICATION (Fed. Spec.)

FS L-P-387 (Rev A; Am 1; Int Am 2) Plastic heet, Laminated, Thermosetting (for Designation Plates)

## 1.2 GENERAL

Interior signage shall be of the sizes and types shown on the attachments at the end of this section shall conform to the requirements specified herein, and shall be provided at the locations indicated. Signs shall be complete with lettering, framing as detailed, and related components for a complete installation. The Contractor shall take any measurements necessary at the jobsite and shall be responsible for proper fitting and hanging of the signs. Signs shall be the standard product of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate signs that have been in satisfactory use at least 2 years prior to bid opening.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTALS PROCEDURES:

SD-01 Data

Interior Signage; GA.

Manufacturer's descriptive data, catalogs cuts and installation instructions.

## SD-04 Drawings

Interior Signage; FIO.

Drawings shall include elevations of each type of sign and shall show dimensions, details and methods of mounting or anchoring, shape and thickness of materials, and details of construction. A schedule showing the location of each sign type shall be included.

## SD-14 Samples

Interior Signage; GA.

Samples of the following signs showing typical quality, color and workmanship. The samples may be installed in the work, provided each sample is identified and location recorded.

- a. Sign type BB3, BB4, BB7M, BB7W, and BB7H

## 1.4 DELIVERY AND STORAGE

Materials shall be delivered to the jobsite in manufacturer's original packaging and stored in a clean, dry area. Signs shall be wrapped with paper, polyethylene film or strippable waterproof tape for shipment and storage and shall be protected during installation. Each completed sign unit shall be individually packaged. Protective paper shall be removed only as necessary during fabrication and installation to avoid scratching, chipping, or crazing the acrylic sheets. In the event of damage to any of the sign components, the Contractor shall replace or repair the components to the approval of the Contracting Officer at no additional cost to the Government.

## 2 PRODUCTS

## 2.1 SILK-SCREENING

Silk-screened images shall be executed from photo screens prepared from original art. No hand-cut screens will be accepted. Original art is defined as artwork that is a first generation reproduction of the specified art. Edges and corners shall be clean.

## 2.2 VINYL SHEETING FOR DIE-CUT GRAPHICS

Vinyl sheeting for die-cut graphics shall be minimum 0.003 inch film thickness. Sheeting shall include a precoated pressure sensitive adhesive backing or positionable pressure sensitive adhesive backing.

## 2.3 VINYL SHEETING FOR INSERTS

Vinyl sheeting for inserts shall be matte finish, 0.38 mm thick, with background color applied subsurface, and shall be designed for the use to which it is herein specified.

## 2.4 PRESSURE SENSITIVE FILM

Pressure sensitive film or other material as recommended by the manufacturer shall be used to laminate the face plate and other layers of the sign together. The film shall be no less than 0.10 mm. thick and shall be applied edge to edge on the sign plaque. No field lamination of the face plate or other layers will be permitted.

## 2.5 ACRYLIC SHEET

Acrylic sheet for panels and components shall conform to ANSI Z97.1.

### 2.5.1 Acrylic Face Sheet

Acrylic face sheet shall be Item A, Type I, Grade B, clear, thickness as shown on the Sign Construction Drawings.

### 2.5.2 Acrylic Spaces Sheet

Acrylic spacer sheet shall be Item A, Type I, Grade C, clear, thickness as shown on the Sign Construction Drawings.

### 2.5.3 Acrylic Back Plate

Acrylic back plate shall be Item A, Type I, Grade C, color of backplate shall be black with thickness as shown on the Sign Construction Drawings.

## 2.6 PAINTS AND INKS

Paints and inks required shall be made for the surface material on which they are to be applied and as recommended by the manufacturer of the paint or ink. Prime coats or other surface pretreatments, where applicable, shall be included in the work. Paints, inks, and all finishes shall be guaranteed not to cause discoloration, deterioration, or delamination of any materials used in the fabrication.

## 2.7 ANCHORS AND FASTENERS

Anchors and fastener materials shall be types as recommended by the manufacturer for anchorage to the indicated substrate. Any exposed anchor and fastener materials shall be compatible with metal to which applied and shall have matching color and finish.

## 2.8 FOAM TAPE PADS

Foam tape pads shall consist of a 1.59 mm thick closed cell vinyl foam with an adhesive backing. Adhesive shall be new, transparent, long aging, high tack formulation on two sides of the vinyl foam. Adhesive surfaces shall be protected with a 0.127 mm green flatstock which is treated with silicone. Foam tape pads shall be black in color and shall be a minimum of 1-inch wide strips. Strips shall be 50 mm in length for signs up to 150 mm by 150 mm in size and 75 mm in length for signs larger than 150 mm by 150 mm. A minimum of four (4) strips per sign shall be provided.

## 2.9 FABRICATION AND MANUFACTURE

### 2.9.1 Workmanship

The construction system shall be engineered to eliminate buckling of any members, failure of any points, distortion or other damage to the completed sign. All components shall be shop fabricated, complete and ready for installation. Holes for bolts and screws shall be drilled or punched.

Drilling and punching shall produce clean, true lines and surfaces. Exposed surfaces of work shall have a smooth finish and exposed riveting shall be flush. Fastenings shall be concealed where practicable.

### 2.9.2 Dissimilar Materials

Where dissimilar metals are in contact, the surfaces will be protected to prevent galvanic or corrosive action.

## 2.10 PLAQUE SIGNS

Plaque signs shall be a modular type signage system. Signs shall be fabricated of Type ES melamine plastic conforming to FS L-P-387, Type NDP self-extinguishing or acrylic conforming to ANSI Z97.1 as shown. All sign components shall be cut clean. Rounded corners where rounded edges are not desired, cut or ragged edges, edge build-up, bleeding or imperfections in the surfaces of the acrylic sheet will not be accepted. All sign components shall be fabricated as shown on the Sign Type and Construction Drawings. All plaque signs shall conform to the following:

- a. Letterforms shall be silk-screened or die-cut Helvetica Medium upper and lower case. Alternate styles will not be approved. Edges and corners of finished letterforms shall be photographically precise, crisp, clean, and free of ticks, discontinuous curves, line wave, cut or ragged edges, edge build-up, bleeding, surface pinholes and other imperfections. All letterforms shall conform to the prescribed letter form proportions.
- b. Letter and numeral sizes shall be as follows:
  1. Room numbers shall be 38 mm in height.
  2. Permanent message shall be 13 mm in height, except as noted otherwise on the Sign Type Drawings.
  3. Insert copy shall be 13 mm in height for all sign inserts.
- c. Vertical spacing shall be as shown on the Sign Type Drawings.
- d. Alignment of letterforms shall maintain a horizontal baseline.
- e. Letter spacing shall be normal. Expanded or condensed spacing is not acceptable.

f. Colors as specified herein shall be consistent in chroma and value, shall maintain proper opacity or translucency and shall be free of blistering, bleeding, fading, and other imperfections.

g. Message copy on Sign Type Drawings is for layout purposes only. Actual copy for signs shall be as scheduled.

h. Color Schedule For Plaque Signs in Barracks: The 3 mm ruled line, separating the header section from the lower section of the sign, as indicated on the sign construction drawings shall match the EIFS color.

Color for the background: Shall match the anodized dark bronze aluminum color. Color for the message shall match the EIFS color.

i. Color Schedule For Plaque Signs in Community Building:

Exterior: (for doors 4-110, 4-117, 4-118, 4-119, 4-120, 4-121, 4-122, 4-123)

The 3 mm ruled line, separating the header section from the lower section of the sign, as indicated on the Sign Construction Drawings shall match the EIFS color.

Color for the background: Shall match the anodized dark bronze aluminum color. Color for the message shall match the EIFS color.

Interior:

The 3 mm ruled line, separating the header section from the lower section of the sign, as indicated on the Sign Construction Drawings shall be white.

Color for the background: Shall match Sherwin Williams, SW 1069 Santa Fe Trail, and color for the message shall be white.

Symbol sign colors shall be as follows: Symbol color: White  
Background color: Shall match Sherwin Williams, SW 1069 Santa Fe Trail.

#### 2.10.1 Plaque Sign Type BB3 with Changeable Message Strip

Plaque sign type BB3 shall consist of matte finish clear acrylic plastic face sheet, laminated to clear acrylic spacers and back plate. The sign shall be fabricated with two (2), 19 mm wide insert slots. Each slot shall accept one (1), 17 mm wide vinyl insert. Thickness and size of sign shall be as shown on the Sign Construction Drawing. Silk-screened or die-cut permanent message, as scheduled, shall be applied subsurface. Corners of signs shall be square.

#### 2.10.2 Insert for Plaque Sign Type BB3

Individual 0.015-inch thick vinyl message insert strips to permit removal, change, and reinsertion shall be provided as detailed. Thickness and size of insert shall be as shown on the Sign Construction Drawing. Silk-screened or die-cut permanent message, as scheduled, shall be applied to the surface. Corners of inserts shall be square.

### 2.10.3 Plaque Sign Type BB4

Plaque sign type BB4 shall consist of matte finish clear acrylic plastic face sheet, laminated to an acrylic back plate. Thickness and size of sign shall be as shown on the Sign Construction Drawing. Silk-screened or die-cut permanent message, as scheduled, shall be applied subsurface. Corners of signs shall be square.

### 2.10.4 Plaque Sign Type BB7M, BB7W, and BB7H

Plaque sign types BB7M, BB7W, and BB7H shall consist of matte finish clear acrylic plastic face sheet, laminated to an acrylic back plate. Thickness and size of sign shall be as shown on the Sign Construction Drawing. Silk-screened or die-cut permanent message, as scheduled, shall be applied subsurface. Corners of signs shall be square.

### 2.10.5 Mounting of Plaque Signs

Surface mounted signs shall be provided with 1.59 mm thick foam tape pads.

## 3 EXECUTION

### 3.1 INSTALLATION

Signs shall be installed at locations shown on the drawings and as scheduled. Signs shall be installed plumb and true at mounting heights indicated, and by method specified. Signs on doors or other surfaces shall not be installed until finishes on such surfaces have been installed.

#### 3.1.1 Anchorage

Fasteners shall be as recommended by the manufacturer for the substrate to which the sign is being installed. All fasteners shall be concealed, with a minimum of two (2) per sign except as indicated otherwise. Anchorage not otherwise specified or indicated shall include slotted inserts, expansion shields, and power-driven fasteners when approved for concrete; toggle bolts and through bolts for masonry; machine carriage bolts for steel; lag bolts and screws for wood.

#### 3.1.2 Protection and Cleaning

The work shall be protected against damage during construction. Hardware shall be adjusted for proper operation. Glass, frames, and other sign surfaces shall be cleaned.

**SIGNAGE SCHEDULE(S)**

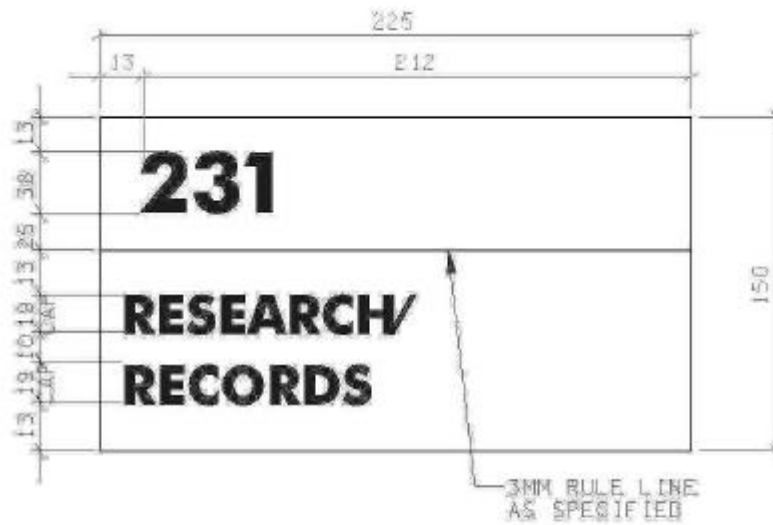
Remarks column indicates sign location: WR - Wall Right, WL - Wall Left, or DL - On Door.

Each Living Unit door (marked as 'BARR1') shall receive a Type BB4 sign indicating the corresponding room number taken from the floor plans (i.e. 1-101, 1-201, 1-301). All signage shall be mounted on the strike side of door, unless otherwise noted.

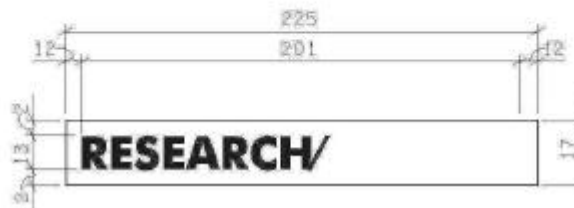
<b>Signage Schedule – Barracks</b>						
Sign No.	Door No.	Room No.	Sign Type	Message Number	Message Wording	Remarks
1	BARR9	1-157	BB3	1-157	Maid	
2	BARR6	1-158	BB3	1-158	Electrical	
3	BARR7	1-159	BB3	1-159	Mechanical	WL
4	BARR8	1-160	BB3	1-160	Mud Room	
5	BARR9	1-257	BB3	1-257	Maid	
6	BARR6	1-258	BB3	1-258	Electrical	
7	BARR7	1-259	BB3	1-259	Mechanical	WL
8	BARR8	1-260	BB3	1-260	Mud Room	
9	BARR9	1-357	BB3	1-357	Maid	
10	BARR6	1-358	BB3	1-358	Electrical	
11	BARR7	1-359	BB3	1-359	Mechanical	WL
12	BARR8	1-360	BB3	1-360	Mud Room	

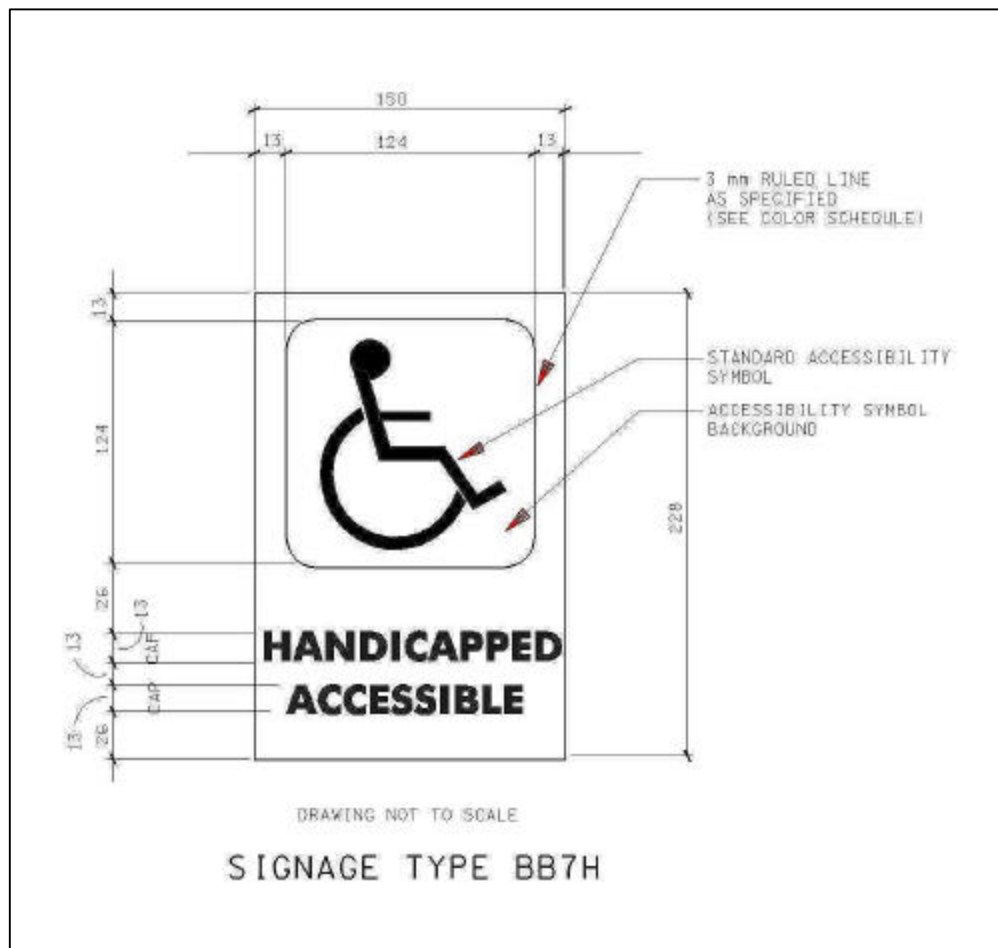
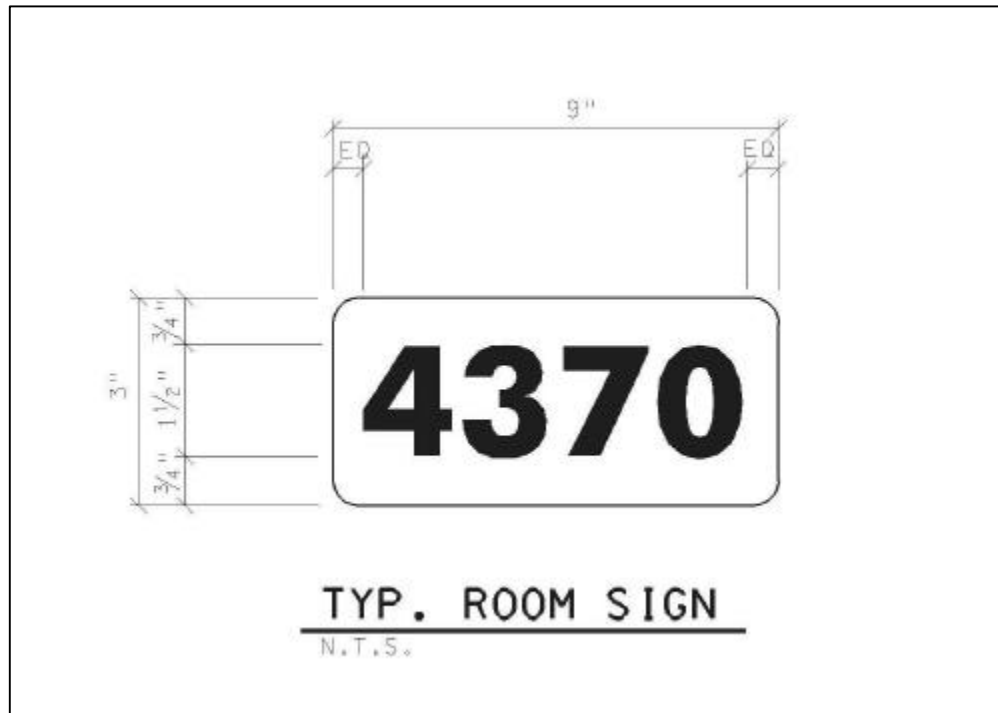
Signage Schedule – Community Building						
Sign No.	Door No.	Room No.	Sign Type	Message Number	Message Wording	Remarks
1	4-102	4-102	BB7W/ BB7H	102	Men	
2	4-103	4-103	BB7W/ BB7H	103	Women	
3	4-104	4-108	BB3	107	Kitchen/Seating	
4	4-106	4-101	BB3	109	Laundry	WL
5	4-106	4-109	BB3	101	Kitchen/Seating	WR
6	4-107	4-118	BB3	108	Kitchen/Laundry/Seating	WL
7	4-108	4-108	BB3	109	Laundry	
8	4-109	4-109	BB3	110	Mud Room	
9	4-109	4-110	BB3	109	Laundry	
10	4-110	4-118	BB3	110	Mud Room	
11	4-111	4-109	BB3	111	Janitor	
12	4-112	4-101	BB3	112	Dryer Chase	
13	4-117	4-118	BB3	115	Telephone	
14	4-118	4-118	BB3	116	Electrical	
15	4-119	4-118	BB3	117	Bulk Storage	WR
16	4-120	4-118	BB3	117	Bulk Storage	WL
17	4-121	4-118	BB3	119	Bulk Storage	WL
18	4-122	4-118	BB3	119	Bulk Storage	WR
19	4-123	4-118	BB3	119	Bulk Storage	WR

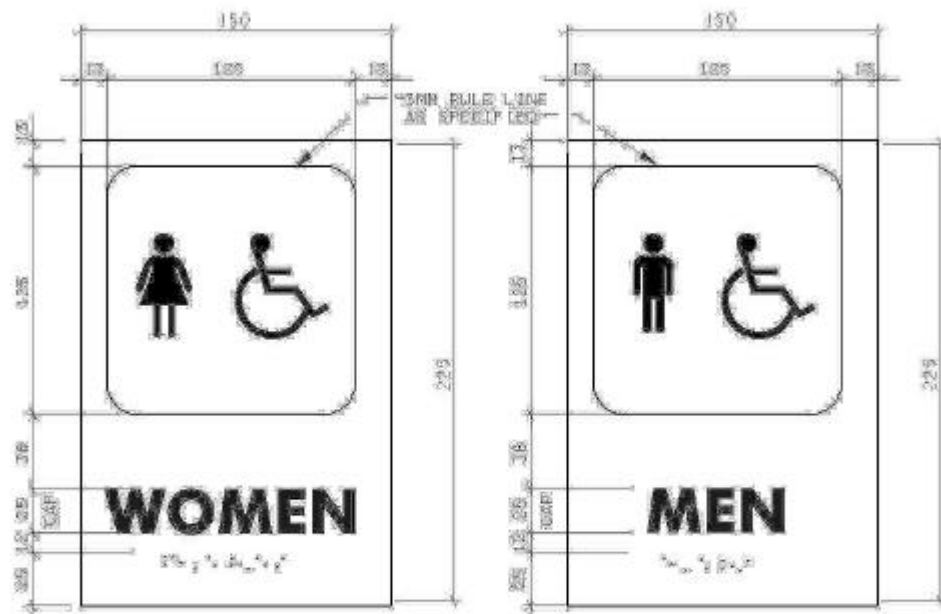




SIGNAGE TYPE BB3W

INSERT FOR SIGNAGE TYPES BB1,  
BB2 AND BB3W



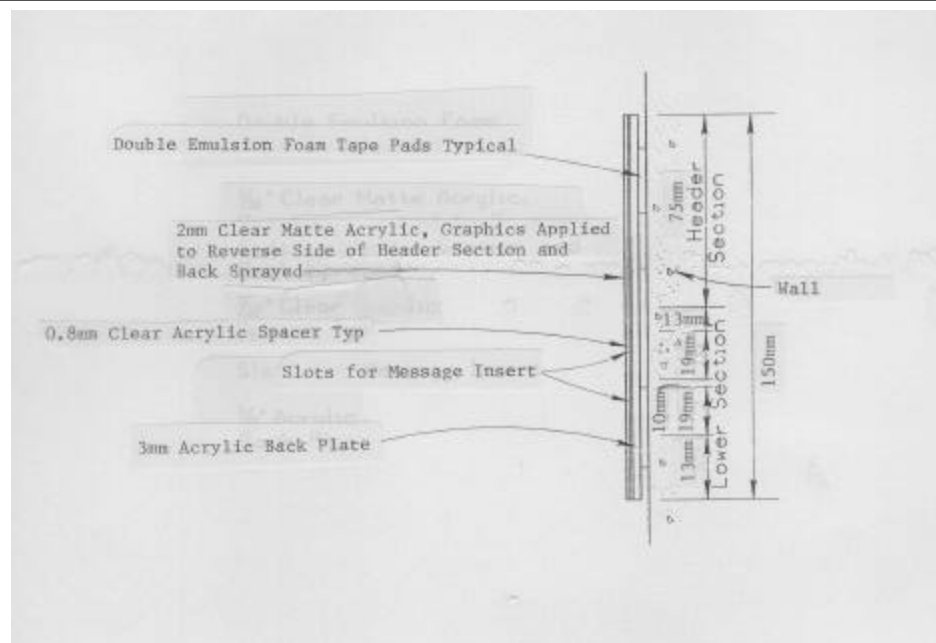


DRAWING NOT TO SCALE

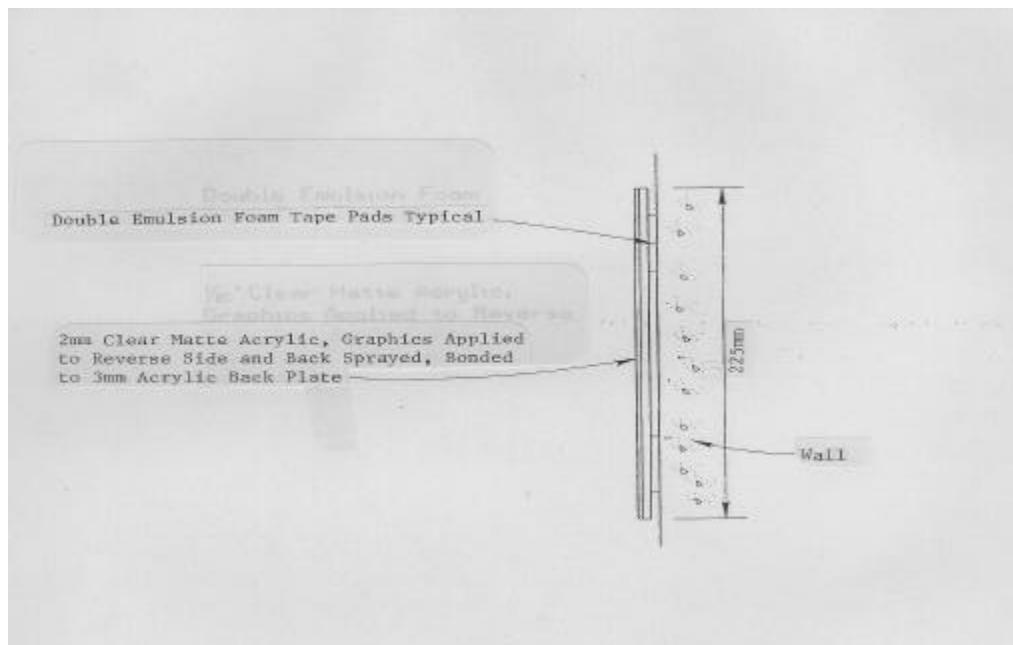
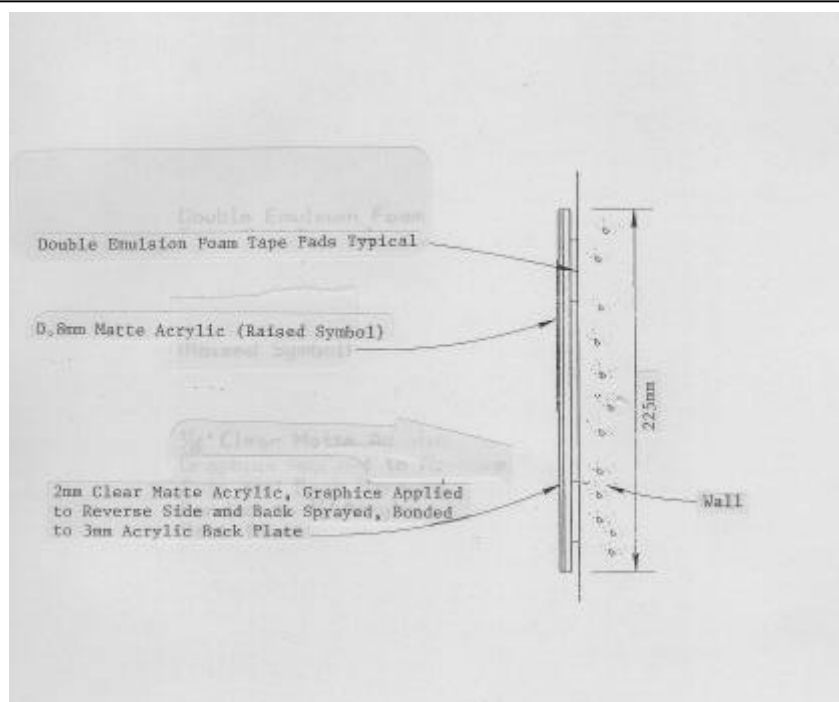
SIGNAGE TYPE BB7W

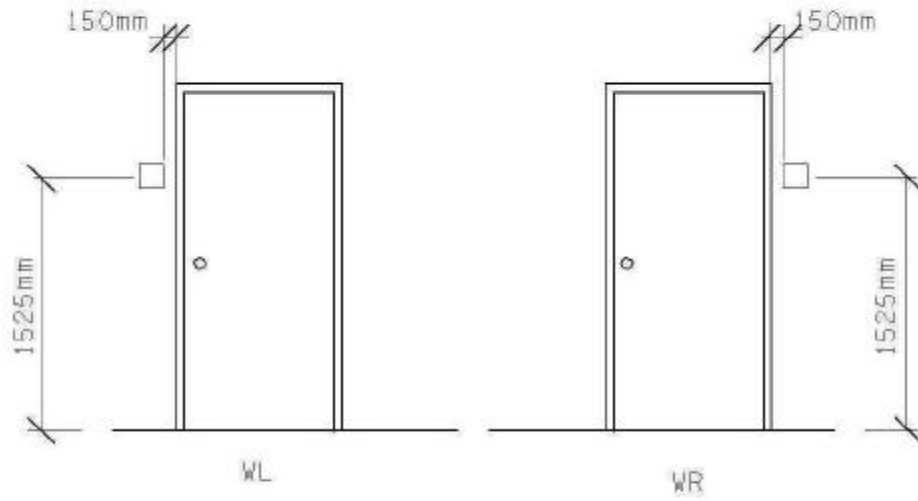
DRAWING NOT TO SCALE

SIGNAGE TYPE BB7M



CONSTRUCTION - SIGNAGE TYPE BB3W 1CONSTRUCTION

**CONSTRUCTION - SIGNAGE TYPE BB7M/BB7W****CONSTRUCTION - SIGNAGE TYPE BB7H**



SIGNAGE INSTALLATION  
NOT TO SCALE

## SECTION 10501

## METAL TENANT STORAGE LOCKERS

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## FEDERAL SPECIFICATIONS (FS)

FS AA-L-486

(Rev. H; Am. 1) Lockers, Clothing, Steel.

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL DESCRIPTIONS:

SD-01 Data

Lockers; FIO.

SD-04 Drawings

Lockers; FIO.

Furnish installation details. The manufacturer's printed literature will be acceptable in lieu of detail drawings provided this literature accurately shows the items proposed to be furnished and the method of installation.

## 2 PRODUCTS

## 2.1 METAL TENANT STORAGE LOCKERS

Metal storage lockers shall be fabricated from steel, with all welded construction. Sizes and configuration shall be as shown.

## 2.1.1 Locker Fronts

All doors, whether single or double tier shall consist of 4.16 mm (8 ga.) galvanized welded wire steel fabric, 38 mm x 75 mm with 25 mm bends around edges of long dimension to provide rigidity, framed by 35 mm x 25 mm, 2.6 mm (12 ga.) formed angles. Single tier doors shall have an angle reinforcement across center. Doors shall be prehung in frames at the factory, with all hinges, padlock hasps and door strikes securely welded in position. Door frames shall be fabricated from 38 mm x 25 mm, 1.9 mm (14 ga.) formed channels on the sides and 38 mm x 25 mm formed angles at top and bottom and include a 330 mm transom. In addition, each individual door frame shall be diagonally reinforced with cold formed channel stock as shown to prevent normal racking or prying of the door from the locker unit while in a closed, locked position. All frames shall be prepunched, if required, for ease of installation. Each and all doors shall also be provided with the following:

heavy-duty magnetic style catches to secure the door from freely swinging (separate from hasp), a hasp or other locking device for use with a user-supplied padlock. Each locker door or frame at door shall be provided with signage in location as shown for identification of owner of contents. Signage shall be a minimum of 150mm long, 100mm high, shall be user changeable and shall be fastened to door in such a method so as to discourage vandalism.

#### 2.1.1.2 Vertical Dividers

Vertical dividers shall be 4.16 mm (8 ga.) galvanized welded wire steel fabric, 38 mm x 75 mm with 25 mm bends around edges of long dimension to provide rigidity. Fabric shall be securely welded to 28 mm x 28 mm, 14 gauge formed angles. Channels shall be provided on both sides to support shelves and bottoms.

#### 2.1.1.3 Shelves and Bottoms

Shelves and bottoms shall be 0.762 mm (22 gauge) galvanized sheet steel with double bend at front and back.

#### 2.1.1.4 Backs

Backs shall be provided of 0.762 mm (22 gauge) galvanized sheet steel minimum.

#### 2.1.1.5 Tops

Tops shall be produced from 4.16 mm (8 ga.) galvanized welded wire steel fabric, 38 mm x 75 mm with 16 gauge angle welded at rear. Provide mounting hardware as required.

#### 2.1.1.6 Finish

All fronts, vertical dividers and tops shall have one dipped coat manufacturers standard gray gloss enamel. Bottoms, shelves and backs shall be galvanized sheet steel, unpainted. Steel fabric shall be galvanized.

### 3 EXECUTION

#### 3.1 INSTALLATION

Metal lockers shall be installed where shown. Each locker unit shall be fabricated with all welded components. Where bolts, screws and other fasteners are absolutely necessary for anchorage of individual locker units to others and to the building, such fasteners shall be located in such discrete locations to avoid being accessible to outsiders either when the lockers are open or closed. If the fasteners are in accessible locations to outsiders, such items shall be completely covered with a minimum 0.762 mm (22 gauge) steel sheet fully welded in place. Dividers and door frames shall be securely anchored to wall and/or floor with an anchoring system selected by the installer. Bracing for free standing rows to be provided by installer. Lockers shall not be installed until after the room painting and finishing operations are complete.

## SECTION 10550

## POSTAL SPECIALTIES

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below forms a part of this specification to the extent referenced. The publication is referred to in the text by the basic designation only.

## U.S. POSTAL SERVICE (USPS)

USPS Publication 17                      Apartment House Mail Receptacles

USPS Publication 18                      Neighborhood Delivery and Collection Boxes

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals with an "FIO" designation are for information only. The following shall be submitted in accordance with SECTION 01300: SUBMITTAL PROCEDURES.

## SD-01 Data

Manufacturer's Catalog Data; FIO.

## SD-04 Drawings

Detail Drawings; GA.

Submit detail drawings showing plans, elevations, details of construction, gages of metal, fittings, mounting, and anchoring for all postal specialty items required for the project.

## 2 PRODUCTS

## 2.1 MAILBOXES

USPS Publication 17, Type II (horizontal), front loading, door sizes (nominal) - 150 mm W. x 127 mm H., compartment depth - 394 mm. Fronts shall be cast or extruded aluminum. Compartments shall be fabricated with sheet aluminum or steel enclosure to match box fronts. Refer to drawings for layout of mailbox units.

## 2.1.1 Box Numbers

Boxes shall be provided with 16 mm H. X 50 mm W. slots, each containing a clear plastic cover and card stock number card held in place with an aluminum backplate. Numbering of boxes shall be in accordance with Publication 17 and the Contracting Officer's directions.

## 2.1.2 Compartment Door Locks

Key cylinders shall be 5-pin tumbler type. 2 keys per lock shall be provided.



### 2.1.3 Finish

Fronts of boxes and associated trim shall be satin anodized aluminum, color-natural.

### 2.2 MAIL DROPS

Mail drops shall be fabricated of extruded aluminum, 1.52 mm or thicker; have a satin anodized natural finish; and have "U.S. MAIL" engraved in 25 mm high letters on the flap door. Door dimensions shall be 279 mm by 89 mm (nominal).

### 2.3 DIRECTORIES

Directories, for sorting identification, shall comply with Publication 17 and shall match the mailboxes in material and finish.

## 3 EXECUTION

### 3.1 INSTALLATION

Mail boxes, mail drops, and directories shall be as shown and as required by USPS Publication 17. Postal accessories shall be installed straight and plumb with all horizontal lines level, and rigidly anchored to the supporting construction. Anchors shall be located so as to be concealed in the finished work.

## SECTION 10800

## TOILET ACCESSORIES

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## COMMERCIAL ITEM DESCRIPTIONS (CID)

CID A-A-2398 (Rev B) Curtain, Shower and Window (Metric - SI)

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation, submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

## SD-01 Data

Finishes; FIO.  
Accessory Items; FIO.

Manufacturer's descriptive data and catalog cuts indicating materials of construction, fasteners proposed for use for each type of wall construction, mounting instructions, and operation instructions.

## SD-14 Samples

Finishes; FIO.  
Accessory Items; FIO.  
Shower Curtain fabric; GA.

One sample of each accessory proposed for use. Approved samples may be incorporated into the finished work, provided they are identified and their locations noted.

## 1.3 DELIVERY, STORAGE, AND HANDLING

Toilet accessories shall be wrapped for shipment and storage, delivered to the jobsite in manufacturer's original packaging and stored in a clean, dry area protected from construction damage and vandalism.

## 2 PRODUCTS

## 2.1 MANUFACTURED UNITS

Toilet accessories shall be provided where indicated in accordance with paragraph SCHEDULE. Porcelain type, tile-wall accessories are specified in Section 09310 CERAMIC TILE. Each accessory item shall be complete with the

necessary mounting plates, shall be of sturdy construction with corrosion resistant surface.

#### 2.1.1 Anchors and Fasteners

Anchors and fasteners shall be capable of developing a restraining force commensurate with the strength of the accessory to be mounted and shall be suited for use with the supporting construction. Exposed fasteners shall be of tamperproof design and shall be finished to match the accessory.

#### 2.1.2 Finishes

Except where noted otherwise, finishes on metal shall be provided as follows:

<u>Metal</u>	<u>Finish</u>
Stainless steel	No. 4 satin finish
Carbon steel, copper alloy, and brass	Chromium plated, bright

### 2.2 ACCESSORY ITEMS

Accessory items shall conform to the requirements specified below.

#### 2.2.1 Grab Bar (GB)

Grab bar shall be 1.3 mm (18 gauge), 32 mm OD Type 304 stainless steel. Grab bar shall be form and length as indicated. Concealed mounting flange shall have set screw mounting holes concealed on the lip of the flange. Grab bar shall have satin finish. Installed bars shall be capable of withstanding a 2.225 kN vertical load without coming loose from the fastenings and without obvious permanent deformation. Space between wall and grab bar shall be 38 mm.

#### 2.2.2 Glass Mirrors

Glass mirror shall be in accordance with Section 08810 GLASS AND GLAZING.

#### 2.2.3 Combination Paper Towel Dispenser/Waste Receptacle Units (PTDWR)

Dispenser/receptacle shall be semi-recessed and shall have a capacity of 600 sheets of C-fold, single-fold, or quarter-fold towel. Waste receptacle shall be designed to be locked in unit and removable for service. Locking mechanism shall be tumbler key lock. Waste receptacle shall have a capacity of 45 L. Unit shall be fabricated of not less than 0.8 mm stainless steel welded construction with all exposed surfaces having a satin finish. Waste receptacle that accepts reusable liner standard for unit manufacturer shall be provided. Unit shall be Bobrick B-3944 or approved equal.

#### 2.2.4 Shower Curtain Rods (SCR)

Shower curtain rods shall be Type 304 stainless steel 32 mm OD by that shown with satin finish to meet installation conditions. Unit shall be Bobrick B-6047 or approved equal.

#### 2.2.5 Soap Dispenser (SD)

Soap dispenser shall be surface mounted, liquid type consisting of a vertical Type 304 stainless steel tank with holding capacity of 1.2 L with a corrosion-resistant all-purpose valve that dispenses liquid soaps, lotions, detergents and antiseptic soaps, and shall have a minimum capacity of 0.94 L. Dispenser shall be Bobrick B-4112 or approved equal.

#### 2.2.6 Soap Dish

Soap dish shall be recessed type in areas as shown and shall be Bobrick B-4390 or approved equal. Unit shall be mounted securely to internal wall supports.

#### 2.2.7 Towel Bar (TB)

Towel bar shall be stainless steel with a minimum thickness of 0.38 mm. Bar shall be minimum 19 mm diameter, or 16 mm square. Length shall be as shown. Finish shall be satin. Towel bar shall be Bobrick B-674 or approved equal.

#### 2.2.8 Towel Pin/Robe Hook (TP)

Towel pin/robe hook shall have concealed wall fastenings, and a pin integral with or permanently fastened to wall flange. Maximum projection shall be 100 mm. Design shall be consistent with design of other accessory items. Finish shall be satin stainless steel. Towel pin/robe hook shall be Bobrick B-677 or approved equal.

#### 2.2.9 Toilet Tissue Dispenser (TTD)

Toilet tissue holder shall be Type II - surface mounted or recessed as shown with two rolls of tissue stacked vertically. Cabinet shall be stainless steel, satin finish. Surface mounted type: Bobrick B-2888 or approved equal. Recessed type: Bobrick B-3888 or approved equal.

#### 2.2.10 Toilet Seat Cover Dispenser (TSCD)

Toilet seat cover dispensers shall be stainless steel and be surface mounted. Dispenser shall have a minimum capacity of 500 seat covers. Dual access dispensers shall have a minimum capacity of 500 seat covers. Dual access dispensers shall have a minimum capacity of 500 seat covers per side. Dispenser shall be Bobrick B-221 or approved equal.

#### 2.2.11 Mop/Broom Holder

Mop/broom holder unit shall be Bobrick B-239 x 44 or approved equal. Unit shall be provided in janitor rooms of all buildings. Locations and mounting height shall be as shown.

### 3 EXECUTION

#### 3.1 INSTALLATION

Toilet accessories shall be securely fastened to the supporting construction in accordance with the manufacturer's approved instructions. Accessories shall be protected from damage from the time of installation until acceptance.

## SECTION 11211

## PUMPS: WATER, CENTRIFUGAL

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- |            |   |
|------------|---|
| ASTM A 123 | (1989a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A 307 | (1994) Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength      |

## AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

- |            |   |
|------------|---|
| ASME B1.1  | (1989) Unified Inch Screw Threads (UN and UNR Thread Form)        |
| ASME B16.1 | (1989) Cast Iron Pipe Flanges and Flanged Fittings                |
| ASME B16.5 | (1988; Errata Oct 1988; B16.5a) Pipe Flanges and Flanged Fittings |
| ASME B40.1 | (1991) Gauges - Pressure Indicating Dial Type - Elastic Element   |

## CODE OF FEDERAL REGULATIONS (CFR)

- |           |                         |
|-----------|-------------------------|
| 47 CFR 15 | Radio Frequency Devices |
|-----------|-------------------------|

## HYDRAULIC INSTITUTE (HI)

- |       |  |
|-------|--|
| HI-01 | (1983) Standards for Centrifugal, Rotary & Reciprocating Pumps |
|-------|--|

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

- |           |  |
|-----------|--|
| NEMA MG 1 | (1993; Rev 1-1993) Motors and Generators |
|-----------|--|

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

- |         |                                 |
|---------|---------------------------------|
| NFPA 20 | (1993) Centrifugal Fire Pumps   |
| NFPA 70 | (1993) National Electrical Code |

## STEEL STRUCTURES PAINTING COUNCIL (SSPC)

- |               |  |
|---------------|--|
| SSPC Paint 21 | (1991) White or Colored Silicone Alkyd Paint |
|---------------|--|

SSPC Paint 25

(1991) Red Iron Oxide, Zinc Oxide, Raw Linseed Oil and Alkyd Primer (without Lead and Chromate Pigments)

## 1.2 GENERAL REQUIREMENTS

### 1.2.1 Standard Products

Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate equipment that has been in satisfactory waterworks operation at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the jobsite. Pumps and motors of the same types shall each be the product of one manufacturer.

### 1.2.2 Description

The pumps shall be horizontal and vertical centrifugal water pumps of the types indicated and specified. The single driving units for the pumps shall be electric motors as indicated and specified.

### 1.2.3 Governing Requirements

Fire pumps and appurtenances shall conform in all respects to NFPA 20.

### 1.2.4 Safety Requirements

Gears, couplings, projecting set-screws, keys, and other rotating parts, so located that any person can come in close proximity thereto, shall be fully enclosed or properly guarded.

### 1.2.5 Nameplates

Pumps and motors shall have a standard nameplate securely affixed in a conspicuous place showing the manufacturer's name, address, type or style, model, serial number, and catalog number. In addition, the nameplate for each pump shall show the capacity in liters per second at rated speed in rpm and head in meters of water. Nameplate for each electric motor shall show at least the minimum information required by 10.38 NEMA MG 1. Such other information as the manufacturer may consider necessary to complete identification shall be shown on the nameplate.

### 1.2.6 Electrical Work

Electrical motor driven equipment specified herein shall be provided complete with motors, motor starters, and controls. Electric equipment and wiring shall be in accordance with Section 16415 ELECTRICAL WORK, INTERIOR. Electrical characteristics shall be as indicated. Equipment for control of automatic fire pumps shall be in accordance with NFPA 20. Motor starters shall be provided complete with properly sized thermal overload protection in each phase and other appurtenances necessary for the motor control specified. Each motor shall be of sufficient capacity to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor when operating at proper electrical system voltage and frequency. Manual or automatic control and protective or signal devices required for the operation herein specified and any control wiring required

for controls and devices but not shown on electrical plans shall be provided under this section of the specifications.

#### 1.2.7 Selection Criteria

Pumps shall be designed using hydraulic criteria based upon actual model developmental test data. Pumps shall be selected at a point within the maximum efficiency for a given impeller casing combination. Deviations within 3 percent of maximum efficiency are permissible, provided the lesser efficiency is not less than the scheduled efficiency. Pumps having impeller diameters larger than 90 percent of the published maximum diameter of the casing or less than 15 percent larger than the published minimum diameter of the casing will be rejected. Acceptable maximum impeller diameter calculations shall not be based on percentage of impeller diameter range for a given casing.

#### 1.2.8 Conformance With Agency Requirements

Where materials or equipment are specified to be an approved type, the seal or label of approval from a nationally recognized testing agency, adequately equipped and competent to perform such services, shall be attached thereto. A written certificate from the testing agency shall accompany the materials or equipment and shall be submitted to the Contracting Officer stating that the items have been tested and that they conform to the applicable requirements of the specifications and to the standards listed herein. The certificate shall indicate the methods of testing used by the testing agency. In lieu of a certificate from a testing agency, published catalog specification data, accompanied by the manufacturer's certified statement to the effect that the items are in accordance with the applicable requirements of the specifications and the referenced standards, will be considered by the Contracting Officer and may be acceptable as evidence that the items conform with agency requirements.

#### 1.2.9 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field and shall advise the Contracting Officer of any discrepancy before performing the work.

#### 1.2.10 Factory Tests

Pumps shall be tested by the manufacturer or a nationally recognized testing agency in compliance with Hydraulic Institute Standards. Where two or more identical pumps are specified, only one representative pump shall be tested. Certified test results shall be submitted to the Contracting Officer.

### 1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:



## SD-01 Data

Materials and Equipment; GA.

Manufacturer's descriptive data and technical literature, performance charts and curves for all impeller sizes for a given casing, catalog cuts, and installation instructions. Spare parts data for each different item of material and equipment specified, after approval of the detail drawings and not later than 2 months prior to the date of beneficial occupancy. Data shall include a complete list of parts and supplies, with current unit prices and source of supply.

## SD-04 Drawings

Centrifugal Pump System; GA.

A complete listing of equipment and materials. Drawings containing complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

## SD-06 Instructions

Centrifugal Pump System; FIO.

Proposed diagrams, instructions, and other sheets, prior to posting. Approved wiring and control diagrams showing the complete layout of the entire system, including equipment, piping valves, and control sequence, framed under glass or in approved laminated plastic, shall be posted where directed. Condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system shall be prepared in typed form, framed as specified above for the wiring and control diagrams, and posted beside the diagrams. The framed instructions shall be posted before acceptance testing of the systems.

Training; GA.

Training course curriculum and training instructions shall be furnished to the Contracting Officer 14 days prior to the start of training.

## SD-09 Reports

Tests; GA.

Test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall indicate the final position of controls.

## SD-19 Operation and Maintenance Manuals

## Centrifugal Pump System; FIO.

Six complete sets of instructions containing the manufacturer's operating and maintenance instructions for each piece of equipment. One complete set at the time the tests procedure is submitted; remaining sets before the contract is completed. Each set shall be permanently bound and shall have a hard cover. The following identification shall be inscribed on the covers: the words "OPERATING AND MAINTENANCE INSTRUCTIONS," name and location of the building, name of the Contractor, and contract number. Flysheets shall be placed before instructions covering each subject. Instruction sheets shall be approximately 216 by 279 mm with large sheets of drawings folded in. Instructions shall include, but not be limited to, the following:

- a. System layout showing piping, valves, and controls.
- b. Approved wiring and control diagrams.
- c. A control sequence describing startup, operation, and shutdown.
- d. Operating and maintenance instructions for each piece of equipment, including lubrication instructions and troubleshooting guide.
- e. Manufacturer's bulletins, cuts, and descriptive data; and parts list and recommended spare parts.

## 1.4 DELIVERY AND STORAGE

All equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

## 2 PRODUCTS

## 2.1 MATERIALS AND EQUIPMENT

Materials and equipment shall be as specified below and as shown, and shall be suitable for the service intended. Materials and equipment shall be new and unused, except for tests. Where two or more pieces of equipment performing the same function are required, they shall be duplicate products of the same manufacturer.

## 2.2 CENTRIFUGAL WATER PUMPS

The pumps shall be the centrifugal, designed for HVAC and domestic water service in the configurations shown on the project documents.

## 2.2.1 Pump Service

The pumps shall be utilized for the following service, domestic hot water recirculation, heating hot water and chilled water circulation for HVAC purposes as shown on the project documents.

### 2.2.2 Pump Drives

The pumps shall have the electric motor driving units, types and sizes as shown and shall be directly connected to the driving units through solid shafts with the manufactures couplings.

### 2.2.3 Pump Construction

Except as below specified, centrifugal water pumps shall be constructed in accordance with the Hydraulic Institute HI-01.

### 2.2.4 Pump Characteristics

The pumps shall be capable of discharging quantities at total discharge heads measured at the discharge flange as shown on the project documents.

Pumps shall operate at optimum efficiencies to produce the most economical pumping system under the conditions encountered and shall be sized to make optimum match with the system head curve. Pumps shall furnish not less than 150 percent of rated capacity at a total discharge head of not less than 65 percent of total rated head. The shutoff total head shall be not greater than 120 percent of total rated head.

### 2.2.5 Pump Casings

Pump casings shall be cast iron unless incompatible with the chilled water brine solution shown and of the design as shown on the project documents.

The casings shall be designed to permit replacement of wearing parts. Horizontal-split casings shall have the suction and discharge nozzles cast integrally with the lower half, so that the upper part of the casings may be removed for inspection of the rotating parts without disturbing pipe connections or pump alignment. Pump casings shall be of uniform quality and free from blowholes, porosity, hard spots, shrinkage defects, cracks and other injurious defects. Defects in casings shall not be repaired except when such work is approved and is done by or under the supervision of the pump manufacturer, and then only when the defects are small and do not adversely affect the strength or use of the casing. Casings shall be single or double volute with flanged piping connections conforming to ASME B16.1, Class 125. The direction of shaft rotation shall be conspicuously indicated. The casing shall have tapped openings for air venting, priming, draining, and suction and discharge gauges. A brass or bronze umbrella or vent cock shall be furnished for venting except where automatic air vents are indicated. Drain openings in the volute, intake, or other passages capable of retaining trapped water shall be located in the low point of such passages.

### 2.2.6 Impellers

Impellers shall be of enclosed design and shall be constructed of bronze, carefully finished with smooth water passageways, and shall be statically and dynamically balanced. Impellers shall be securely keyed to the pump shaft.

### 2.2.7 Wearing Rings

Wearing rings of bronze shall be provided for impellers. Wearing rings of a different composition or of a suitable ferrous material shall be provided for pump casings. Casing rings shall be securely fixed in position to prevent rotation. Rings shall be renewable and designed to ensure ease of maintenance.

### 2.2.8 Shaft

Shaft shall be of high grade steel, accurately machined, and shall be of sufficient size and strength to perform the work required. Vertical shafts shall be the closed type and shall be adequately provided with alignment bearings. Bronze renewable shaft sleeves shall be provided for protection of the shaft in contact with water, and in the stuffing boxes. Shaft sleeves shall be keyed to the pump shaft.

### 2.2.9 Packing Seals - Chilled Glycol/Water Mixture Systems Circulators

Packing shall be non-asbestos. Pump shall be shipped to the site without the packing inserted and shall be packed onsite in the presence of the pump or packing manufacturer's representative. At no time during startup or run-in shall the gland drip less water than 80 drops per minute. After not less than 40 operating hours and upon permission of the Contracting Officer, leakage rate may be reduced to 50 drops per minute or to the rate recommended by packing manufacturer.

#### 2.2.9.1 Gland

Gland shall be split-bronze type with AISI 18-8 stainless steel eyebolts and pins or studs. Hex-nuts shall be bronze or non-galling stainless steel.

#### 2.2.9.2 Stuffing boxes

Stuffing boxes exposed to below atmospheric pressure at any operating condition, including starting, shall be provided with a water seal. Water seal shall consist of nonferrous lantern ring or a seal cage and required connections to the pump case.

### 2.2.10 Mechanical Seals

Mechanical seals shall be balanced or unbalanced, as necessary to conform to specified service requirements. Mechanical seals shall be constructed in a manner and of materials particularly suitable for the temperature service range and quality of water being pumped. Seal construction shall not require external source cooling for pumped-fluid service temperatures up to 120 degrees C. Seal pressure rating shall be suitable for maximum system hydraulic conditions. Materials of construction shall include AISI 300 series stainless steel, solid tungsten-carbide rotating-seal face, and Buna-N vinylidene-fluoride-hexafluoropropylene, EPT, or tetrafluoroethylene seals. Bypass flushing water supply shall be free of iron rust products and other abrasive materials and shall be directed onto face of seal without dead ending. All piping and accessories shall be provided. Throttling bushing shall have clearances to minimize leakage in case of complete seal failure without restriction of flushing water. Mechanical seals shall not be subjected to hydrostatic test pressures in excess of the manufacturer's recommendations.

### 2.2.11 Couplings

Couplings shall be of the heavy-duty flexible type, keyed and locked to the shaft. The outside surface of the couplings for horizontal pumps and close-coupled vertical pumps shall be machined parallel to the axis of the shaft. The faces of the couplings shall be machined perpendicular to the axis of the shaft. Disconnecting the couplings shall be accomplished without removing the driver half or the pump half of the couplings from the shaft. Couplings for vertical pumps other than close-coupled vertical pumps may be of the universal type. Flexible couplings shall not be used to compensate for misalignment of pump.

### 2.2.12 Balance

All rotating parts of the equipment shall operate throughout the required range without excessive end thrust, vibration, or noise. Defects of this type that cannot be eliminated by installation adjustments will be sufficient cause for rejection of the equipment. Pump impeller assemblies shall be statically and dynamically balanced to within 1/2 percent of  $W$  times  $R$  squared, where  $W$  equals weight and  $R$  equals impeller radius. Shaft construction shall be substantial to prevent seal or bearing failure due to vibration. Total shaft peak-to-peak dynamic deflection measured by vibrometer at pump-seal face shall not exceed 0.051 mm under shutoff-head operating conditions. Flow from 8 mm iron pipe size (ips) pipe shall be provided during testing.

### 2.2.13 Bearings

Bearings shall be ball or roller type, and the main bearings shall take all radial and end thrust. Pumps that depend only on hydraulic balance to overcome end thrust will not be acceptable.

### 2.2.14 Lubrication

Bearings on horizontal-shaft pumps shall be grease type. Grease type bearings shall be provided with fittings for a grease gun and, if the bearings are not easily accessible, with grease tubing extending to convenient locations. The grease fittings shall be of a type that prevent over lubrication and the buildup of pressure injurious to the bearings.

### 2.2.15 Base Plates

Horizontal-shaft centrifugal pumps shall be provided with a common base for mounting each pump and driving unit of the pump on the same base. Each base shall be constructed of cast iron with a raised lip tapped for drainage, or of welded steel shapes with suitable drainage pan. Horizontal-shaft end suction pumps shall be mounted on a factory furnished channel steel frame. With the exception of close-coupled pumps, horizontal-shaft end suction pumps shall be frame mounted. Vertical-shaft pumps shall be provided with complete mounting suitable for the type of pump furnished, with the base for the pump separate from the base of the driving unit. The drainage structure shall collect the packing box leakage and shall have a 15 mm NPT connection to connect it to a drain.

#### 2.2.16 Cocks, Plugs, and Accessories

The pumps shall be equipped with air cocks, drain plugs, and duplex gauges indicating discharge pressures for all pumps. Gauges, equipped with a shutoff cock and snubber, shall conform to ASME B40.1, and shall be calibrated in kilopascals and pounds per square inch in not more than 10 kPa and 2 psi increment[s]. Gauge ranges shall be appropriate for the particular installation. Normal operating suction and discharge pressures of the pump shall be indicated on the mid-point range of the gauges.

#### 2.2.17 Piping Connections

The pump suction and discharge shall be provided with flanged connections of suitable size and suitably arranged for piping shown. Pipe flanges shall conform to ASME B16.1 and ASME B16.5. Piping shall be installed to preclude the formation of air pockets.

#### 2.2.18 Finish

Pump shall have painted or enameled finish as is standard with the manufacturer except that fire pumps shall be red in color.

### 2.3 ELECTRICAL EQUIPMENT

Electrical equipment shall conform to Section 16415 ELECTRICAL WORK, INTERIOR. Electrical motor driven equipment herein specified shall be provided complete with motors, motor starters, and controls. Motor controls, equipment, and wiring shall be in accordance with NFPA 70.

#### 2.3.1 Electric Motors

Each electric motor-driven pump shall be driven by a weather-protected totally-enclosed fan cooled continuous-duty electric motor. Motor shall have a 1.15 service factor. Motors shall be synchronous motors having normal-starting-torque and low-starting-current characteristics, and shall be of sufficient size so that the nameplate horsepower rating will not be exceeded throughout the entire published pump characteristic curve. Motor bearings shall provide smooth operations under the conditions encountered for the life of the motor. Adequate thrust bearing shall be provided in the motor to carry the weight of all rotating parts plus the hydraulic thrust and shall be capable of withstanding upthrust imposed during pump starting and under variable pumping head conditions specified. Motors shall be rated electrically rated as shown on the project documents and such rating shall be stamped on the nameplate. Motors, not driving fire pumps, shall conform to NEMA MG 1.

#### 2.3.2 Control Equipment

Manually controlled pumps shall have START-STOP pushbutton in cover. Automatically controlled pumps (by EMCS or Local Controls) shall have three-position "MANUAL-OFF-AUTOMATIC" selector switch in cover. Additional controls or protective devices shall be as indicated.

#### 2.3.3 Variable Speed Controls

The variable speed motor controller shall convert 460 volt plus 15 percent, minus 5 percent, three phase, 60 Hz (plus or minus 2 Hz) utility power to

adjustable voltage/frequency, three phase, ac power for stepless motor control from 5 percent to 105 percent of base speed.

#### 2.3.3.1 Description

The variable speed drive shall produce an adjustable ac voltage/frequency output for complete motor speed control. The variable speed drive shall be automatically controlled by a grounded electronic control signal. The variable speed drive shall be self contained, totally enclosed in a NEMA MG 1 ventilated cabinet and capable of operation between 0 and 40 degrees C. The variable speed drive maximum output current rating shall be equal to or exceed the motor nameplate full load. The manufacturer shall advise the maximum recommended motor sine wave current for each controller rating. Variable speed drive multiple motor operation at same frequency/speed shall be possible as long as the sum of connected motor full load sine wave currents are less than or equal to the variable speed drive maximum continuous current rating. Variable speed drive shall be 95 percent efficient at 100 percent rated output power, 60 Hz.

#### 2.3.3.2 Governing Requirements

Variable speed drives shall conform to the following requirements:

- a. Variable speed drive shall comply with 47 CFR 15 regulation of RF1/EM1 emission limits for Class A computing devices. The FCC label of compliance shall be displayed on the variable speed drive.
- b. The variable speed drive and options shall comply with the applicable requirements and the standards of the American National Standards Institute (ANSI).
- c. Variable speed drive and option design and construction thereof shall comply with all applicable provisions of NFPA 70, Article 43D, Sections A-L.

#### 2.3.3.3 Quality Assurance

To ensure quality the variable speed drive shall be subject to the following tests:

- a. The integrated circuits shall undergo a 160-hour "burn-in" to test reliability. During the "burn-in" the temperature shall be cycled between 0 and 70.0 degrees C (32 and 158 degrees F).
- b. The completed unit shall undergo a fully loaded 24-hour "burn-in."
- c. The unit shall be subject to a series of in-plant quality controlled inspections before approval for shipment from manufacturer's facilities.

#### 2.3.3.4 Service

The variable speed drive shall be supplied with the following:

- a. One-year parts and labor warranty.

- b. A troubleshooting guide to help the building operator determine what steps must be taken to correct any problem that may exist in the system.

#### 2.3.3.5 Basic Features

The variable speed drive shall have the following basic features:

- a. Hand/Off/Auto Operation.
- b. Manual/Auto speed reference switch.
- c. Minimum/maximum adjustable speeds.
- d. Speed potentiometer.
- e. Auto restart.
- f. Linear timed acceleration and deceleration for soft starting/stopping.
- g. 3-63 Hz controlled speed range. (Factory set at 15 Hz minimum).
- h. Terminal connections for time clock control, fire, smoke, freeze detectors, and EP relay pre-set speed override.
- i. Output frequency terminals for remote metering.

#### 2.3.3.6 Protective Circuits and Features

The variable speed drive controller shall include the following protective circuits/features:

- a. Current limits to 100 percent design by slowing down motor.
- b. Instantaneous Electronic Trip - automatically shutdown motor if current exceed 120 percent of design or phase-to-phase output short circuit occurs.
- c. The variable speed drive will restart automatically when input line returns to normal in the event of intermittent power outage or phase loss or overvoltage shutdown.
- d. Input power protection shuts down the unit if the following faults occur; low input line voltage or loss of an input phase.
- e. Insensitive to incoming power phase.
- f. Fast acting current limiting input fuses, (Class J) rated with 200,000 interrupting amperes capability.
- g. Isolated 115 volt control circuit and dedicated control transformer.
- h. Line-to-line fault protection.



- i. Line-to-ground short circuiting and accidental motor grounding protection.
- j. Output thermal overload relay trip.

#### 2.3.3.7 Adjustments

The variable speed drive has the following adjustments available via potentiometers located on the faceplate of a single, regulator printed circuit board.

- a. Minimum speed: 0-75 percent
- b. Maximum speed: 100 percent

### 2.4 EQUIPMENT APPURTENANCES

#### 2.4.1 Attachments

All necessary bolts, nuts, washers, bolt sleeves, and other types of attachments for the installation of the equipment shall be furnished with the equipment. Bolts shall conform to the requirements of ASTM A 307 and nuts shall be hexagonal of the same quality as the bolts used. Threads shall be clean-cut and shall conform to ASME B1.1. Bolts, nuts, and washers specified to be galvanized or not otherwise indicated or specified, shall be zinc coated after being threaded, by the hot-dip process conforming to ASTM A 123 as appropriate. Bolts, nuts, and washers specified or indicated to be stainless steel shall be Type 316.

#### 2.4.2 Equipment Guards

Equipment driven by open shafts, belts, chains, or gears shall be provided with all-metal guards enclosing the drive mechanism. Guard shall be constructed of galvanized sheet steel or galvanized woven wire or expanded metal set in a frame of galvanized steel members. Guards shall be secured in position by steel braces or straps which will permit easy removal for servicing the equipment. The guards shall conform in all respects to all applicable safety codes and regulations.

#### 2.4.3 Tools

A complete set of all special tools which may be necessary for the adjustment, operation, maintenance, and disassembly of all equipment shall be furnished. Special tools are considered to be those tools which because of their limited use are not normally available, but which are necessary for the particular equipment. Special tools shall be high-grade, smooth, forged, alloy, tool steel. One pressure grease gun for each type of grease required for motors shall also be furnished. All tools shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such tools until completion of the work, at which time they shall be delivered to the Contracting Officer.

#### 2.4.4 Shop Painting

All motors, pump casings, and similar parts of equipment customarily finished in the shop shall be thoroughly cleaned, primed, and given two finish coats of paint at the factory in accordance with the recommendations

of the manufacturer. Ferrous surfaces not to be painted shall be given a shop coat of grease or other suitable rust-resistant coating.

### 3 EXECUTION

#### 3.1 INSTALLATION

Each pump shall be installed in accordance with the written instructions of the manufacturer.

##### 3.1.1 Concrete Foundations

Concrete for equipment foundations shall be as specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. Concrete foundations shall be integral with and of the same class as that of the building floor unless otherwise indicated. Concrete having a compressive strength of at least 17 MPa shall be used in foundations that are entirely separated from the surrounding floor. A premolded filler strip shall be installed between the foundation and floor slab as shown. Foundation bolts, as required, shall be furnished for proper positioning during the placement of the concrete.

#### 3.2 TESTS

After installation of the pumping units and appurtenances is complete, operating tests shall be carried out to assure that the pumping installation operates properly. Each pumping unit shall be given a running field test in the presence of the Contracting Officer for a minimum of 2 hours with each combination of electric motor. Each pumping unit shall be operated at its rated capacity or such other point on its head-capacity curve selected by the Contracting Officer. The Contractor shall provide an accurate and acceptable method of measuring the discharge flow. Tests shall assure that the units and appurtenances have been installed correctly, that there is no objectionable heating, vibration, or noise from any parts, and that all manual and automatic controls function properly. If any deficiencies are revealed during any tests, such deficiencies shall be corrected and the tests shall be reconducted.

#### 3.3 FIELD PAINTING

Stainless steel, galvanized steel, and nonferrous surfaces shall not be painted.

##### 3.3.1 Touch-Up Painting

Factory painted items requiring touching up in the field shall be thoroughly cleaned of all foreign material and shall be primed and topcoated with the manufacturer's standard factory finish.

##### 3.3.2 Exposed Ferrous Surfaces

Exposed ferrous surfaces shall be painted with two coats of enamel paint conforming to SSPC Paint 21. Factory primed surfaces shall be solvent-cleaned before painting. Surfaces that have not been factory primed shall be prepared and primed with one coat of SSPC Paint 25 or in accordance with the enamel paint manufacturer's recommendations.

### 3.4 DEMONSTRATION

Upon completion of the work and at a time designated by the Contracting Officer, the services of one or more competent engineers shall be provided by the Contractor for a period of not less than 4 hours to instruct a representative of the Government in the operation and maintenance of equipment furnished under this section of the specifications. These field instructions shall cover all the items contained in the bound instructions.

## SECTION 11450

## RESIDENTIAL APPLIANCES

## 1 GENERAL

## 1.1 GENERAL REQUIREMENTS

## 1.1.1 Standard Products

Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products. Items of equipment shall essentially duplicate equipment that has been in satisfactory use at least 2 years prior to bid opening.

## 1.1.2 Nameplates

Each major item of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

## 1.1.3 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

## SD-04 Drawings

Detail Drawings; FIO.

Detail drawings shall be submitted and shall include a complete list of equipment and materials, including manufacturer's descriptive and technical literature; performance charts; catalog cuts; drawings; factory test results; and instructions necessary for installation of the appliances. Detail drawings shall also contain complete piping and wiring drawings and schematic diagrams; equipment layout and anchorage; and any other details required to demonstrate that the units will properly function as a unit. Drawings shall indicate clearances required for maintenance and operation.

## SD-09 Reports

Test Reports; FIO.

Upon completion and testing of the installed system, test reports shall be submitted in booklet form showing all field tests performed, adjustments made, and that tests performed prove that all units can operate properly.

## SD-19 Operation and Maintenance Manuals

Operating Instructions; FIO.

The Contractor shall furnish the Contracting Officer six complete copies of operating instructions outlining the step-by-step procedures required for operation and shutdown and listing routine maintenance procedures, possible breakdowns, and repairs. The instructions shall include simplified wiring and control diagrams. The instructions shall include the manufacturer's names, model numbers, service manuals, parts list, and brief description of all equipment and its basic operating features.

## SD-01 Data

Spare Parts Data; FIO.

Contractor shall furnish spare parts data for each different item of equipment specified. The data shall include a complete list of parts and supplies, with source of supply.

## 1.3 WARRANTY

All appliances shall have a standard total one year warranty. In addition, the washer shall have a two year motor warranty, a three year transmission warranty, and a lifetime warranty on the stainless steel tub.

## 2 PRODUCTS

## 2.1 GENERAL

The appliances shall be matching in appearance. The range, dishwasher, and microwave shall be of one manufacturer. The units shall be capable of fitting within the spaces shown on the drawings. Each unit shall be totally serviceable from the front. Units shall be furnished complete with all attachments necessary for electrical, plumbing, and venting connections.

## 2.2 ELECTRIC RANGE

The range shall be slide-in 762 mm wide General Electric JBP95W or equal. The range shall be electric, self cleaning oven, electronic clock, control, and ignition, 4 burners, white on white with white oven glass.

## 2.3 MICROWAVE OVEN

Microwave oven shall be built-in 762 mm wide General Electric Profile, Model JEB1090WV or equal. The range shall be white on white, with 0.028 cubic meter cavity minimum, and rated at 800 watts minimum.

## 2.4 DISHWASHER

Dishwasher shall be slide-in 762 mm wide General Electric Model GSD4930ZWW or equal. Unit shall be 4 cycle minimum, white on white, solid state controls.

## 2.5 GARBAGE DISPOSER

Garbage disposer shall be General Electric Model GFC800V or equal. Unit shall be 1/2 HP, deluxe sound insulation, stainless steel grinding chamber.

## 2.6 RANGE HOOD

The range hood shall be non-vented General Electric Model JN322S or equal, 762 mm width, factory finished white in color. Hood shall have two speed fan and cooktop light.

## 2.7 AUTOMATIC FIRE EXTINGUISHING SYSTEM

The automatic fire extinguishing system shall be provided within the non-vented range hood at each range location. The system shall be a wet chemical extinguishing system designed to detect a cooking grease fire, extinguish the fire, prevent re-ignition and automatically shut off the gas or electric supply to surface elements on the range. The unit shall discharge chemical from fixed nozzles by means of expellant gas. The system shall comply with the NFPA and UL standards. The system shall consist of a pre-assembled extinguisher kit, piping kit, and detection kit. The system shall be The Guardian Residential Range top Extinguishing System as manufactured by Twenty First Century, Irving, TX (1 800 786-2178).

## 2.8 ICEMAKER

Icemaker shall be General Electric, model ZDIW50Y or equal, 454 mm wide x 874 mm high x 606 mm deep, factory finished white in color.

## 3 INSTALLATION

### 3.1 GENERAL

Appliances shall be installed in accordance with the manufacturer's instruction and recommendations and as shown on the drawings.

### 3.2 ELECTRICAL WORK

Electrical installations shall conform to the requirements of the NFPA 70, and with the applicable requirements of Section 16415 - ELECTRICAL WORK, INTERIOR.

### 3.3 TESTING

The appliances shall each be given a full operating test.

## SECTION 12490

## WINDOW TREATMENT

## PART 1 WORK DESCRIPTION

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## FEDERAL SPECIFICATIONS (FS)

FS AA-V-00200

(Rev B) Venetian Blinds

## 1.2 GENERAL

Window treatment shall be provided, complete with necessary brackets, fittings, and hardware. Each window treatment type shall be a complete unit provided in accordance with paragraph WINDOW TREATMENT PLACEMENT SCHEDULE. Equipment shall be mounted and operated as indicated. Windows to receive a treatment shall be completely covered. The Contractor shall take measurements at the building and shall be responsible for the proper fitting and hanging of the equipment.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

## SD-01 Data

Window Treatments and Hardware; FIO.

Manufacturer's data composed of catalog cuts, brochures, product information, and maintenance instructions.

## SD-04 Drawings

Window Treatments and Hardware; FIO.

Drawings showing fabrication and installation details. Drawings shall show layout and locations of track, direction of draw, mounting heights, and details.

## SD-14 Samples

Window Treatments and Hardware; GA.

Three samples of each type and color of window treatment. Blind slats or louvers shall be 150 mm in length for each color. Track shall be 150 mm in length. Shade material shall be minimum 150 x 150 mm in size.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

Components shall be delivered to the jobsite in the manufacturer's original packaging with the brand or company name, item identification, and project reference clearly marked. Components shall be stored in a dry location that is adequately ventilated and free from dust, water, or other contaminants and shall have easy access for inspection and handling. Materials shall be stored flat in a clean dry area with temperature maintained above 10 degrees C.

#### 1.5 FIELD MEASUREMENTS

The Contractor shall become familiar with details of the work, verify dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

#### 1.6 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period shall be provided.

#### 1.7 EXTRA MATERIALS

Extra materials shall be provided in the amount of 10% for future maintenance use.

### PART 2 PRODUCTS

#### 2.1 WINDOW BLINDS

Each blind, including hardware, accessory items, mounting brackets and fastenings, shall be provided as a complete unit produced by one manufacturer. All parts shall be one color unless otherwise shown, and match the color of the blind slat. Steel features shall be treated for corrosion resistance.

##### 2.1.1 Horizontal Blinds

Horizontal blinds shall conform to FS AA-V-00200, Type II (25 mm slats), 4.16 mm (8 ga.) except as modified below. Blind units shall be capable of nominally 180 degree partial tilting operation and full-height raising. Blinds shall be inside mount as shown.

##### 2.1.1.1 Head Channel and Slats

Head channel shall be steel or aluminum nominal 0.61 mm for Type II. Slats shall be aluminum, not less than 0.203 mm thick, and of sufficient strength to prevent sag or bow in the finished blind. A sufficient amount of slats shall be provided to assure proper control, uniform spacing, and adequate overlap.

##### 2.1.1.2 Controls

The slats shall be tilted by a transparent tilting wand, hung vertically by its own weight, and shall swivel for easy operation. The tilter control shall be of enclosed construction. Moving parts and mechanical drive shall be made of compatible materials which do not require lubrication during



normal expected life. The tilter shall tilt the slats to any desired angle and hold them at that angle so that any vibration or movement of ladders and slats will not drive the tilter and change the angle of slats. A mechanism shall be included to prevent over tightening. The wand shall be of sufficient length to reach to within 1500 mm of the floor.

#### 2.1.1.3 Intermediate Brackets

Intermediate brackets shall be provided for installation of blinds over 1500 mm wide and shall be installed as recommended by the manufacturer.

#### 2.1.1.4 Hold-Down Brackets

Universal type hold-down brackets for sill or jamb mount shall be provided.

### 2.3 COLOR

Color shall be in accordance with Section 09915 COLOR SCHEDULE.

## PART 3 EXECUTION

### 3.1 WINDOW TREATMENT PLACEMENT SCHEDULE

Window blinds shall be provided for all exterior and interior windows in buildings within project, unless noted otherwise.

### 3.2 INSTALLATION

Installation shall be in accordance with the approved detail drawings and manufacturer's installation instructions. Units shall be level, plumb, secure, and at proper height and location relative to window units. The Contractor shall furnish and install supplementary or miscellaneous items in total, including clips, brackets, or anchorages incidental to or necessary for a sound, secure, and complete installation. Installation shall not be initiated until completion of room painting and finishing operations. Upon completion of the installation, window treatments shall be adjusted for form and appearance, shall be in proper operating condition, and shall be free from damage or blemishes. Damaged units shall be repaired or replaced by the Contractor as directed by the Contracting Officer.

## SECTION 12690

## ENTRY FLOOR MAT

## 1 GENERAL

## 1.1 REFERENCES (NOT APPLICABLE)

## 1.2 SUMMARY

This section covers entry mats without frames.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having a "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

## SD-04 Drawings

Entry Mat; FIO.

Drawings or catalogue cuts shall be submitted. The information shall indicate the design, edging details, and all other pertinent portions of the mat design.

## SD-14 Samples

Entry Mat; GA.

A 75mm x 75 mm size sample of the specified mat shall be submitted to indicate pattern, color and style of mat. A 300 mm long sample of the recessed mat frame shall be submitted indicating configuration and method of anchorage.

## 2 PRODUCTS

## 2.1 ENTRY MAT

Entry mat shall be solution-dyed nylon pile bonded to backing.

## 2.1.1 Nylon Pile

Mat shall be cut solution-dyed nylon pile permanently bonded to vinyl or rubber backing, size shown on drawings. Color as indicated in Section 09915 COLOR SCHEDULE.

## 2.2 RECESSED FRAME

Frame shall be heavy gauge 6063 T-5 aluminum, factory preassembled with mitered corners complete with integral concrete strap anchors, fabricated to the size indicated.

### 3 EXECUTION

#### 3.1 INSTALLATION

The frame recess shall be verified prior to fabricating the mat. The frame and mat shall be installed in the recess in accordance with the manufacturers instructions and shall be placed after final cleaning of finish floor.

## SECTION 13080

## SEISMIC PROTECTION FOR MECHANICAL, ELECTRICAL EQUIPMENT

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36	(1996) Carbon Structural Steel
ASTM A 153	(1996) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 307	(1994) Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
ASTM A 563	(1994) Carbon and Alloy Steel Nuts
ASTM A 603	(1994) Zinc-Coated Steel Structural Wire Rope
ASTM A 653	(1996) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM E 488	(1990) Strength of Anchors in Concrete and Masonry Elements
ASTM E 580	(1991) Application of Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels in Areas Requiring Seismic Restraint

## AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.2.1	(1981; Supple 1991; R 1992) Square and Hex Bolts and Screws (Inch Series)
ASME B18.2.2	(1987; R 1993) Square and Hex Nuts (Inch Series)

## INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS (ICBO)

ICBO-01	(1994) Uniform Building Code (3 Vol.)
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## SHEET METAL &amp; AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA-12	(1991; Appx E, 1993) Seismic Restraint Manual Guidelines for Mechanical Systems
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## UNDERWRITERS LABORATORIES (UL)

UL 1570	(1995) Fluorescent Lighting Fixtures
UL 1571	(1991; Rev thru Mar 95) Incandescent Lighting Fixtures

## 1.2 SYSTEM DESCRIPTION

## 1.2.1 General

The requirements for seismic protection measures described in this section shall be applied to mechanical/electrical equipment and systems specified herein. Seismic protection requirements shall be in accordance with ICBO-01 using an importance factor of 1.0 and shall be provided in addition to any other requirements called for in other sections of these specifications. This facility shall be designed as being in seismic zone 1; no other zone values shall be used to establish bracing requirements. Lateral support against earthquake induced forces shall be accomplished by positive attachments without consideration of friction resulting from gravity loads.

## 1.2.2 Mechanical/Electrical Equipment

Mechanical/electrical equipment shall include the following items to the extent required on the drawings or in other sections of these specifications:

- Water Heaters
- Water Chiller Units
- Control Panels
- Pumps with Motors
- Light Fixtures
- Motor Control Centers
- Switchboards (Floor Mounted)
- Boilers
- Water and Gas Piping
- Cable Trays
- Ducts
- Air Handling Units
- Switchgear
- Unit Substations
- Transformers
- Unit Heaters
- Suspended Ceiling Assemblies
- Fan Coil Units
- Exhaust Fans

## 1.2.3 Mechanical/Electrical Systems

The following mechanical and electrical systems shall be installed as required on the drawings and other sections of these specifications and shall be seismically protected in accordance with this specification:

- All Piping Inside the Building in Accordance With This Specification
- Chilled Water Distribution Systems Outside of Buildings
- Gas Distribution Systems
- All Water supply Systems

Storm and Sanitary Sewer systems  
All Process Piping  
Outside Heat Distribution, Return, and Condensate systems

#### 1.2.4 Equipment and Systems

The bracing for the following mechanical/electrical equipment and systems shall be developed by the Contractor in accordance with the requirements of this specification:

#### 1.2.5 Exclusion

Seismic protection of piping for fire protection systems shall be installed as specified in Sections 15330 WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION, 15331 DRY PIPE SPRINKLER SYSTEM, FIRE PROTECTION.

#### 1.2.6 Pipes and Ducts Requiring No Special Seismic Restraints

Seismic restraints may be omitted from the following installations:

- a. Gas piping less than 25 mm inside diameter.
- b. Piping in boiler and mechanical equipment rooms less than 32 mm inside diameter.
- c. All other piping less than 38 mm inside diameter.
- d. Electrical conduit less than 64 mm inside diameter.
- e. Rectangular air handling ducts less than 0.37 square meters in cross sectional area.
- f. Round air handling ducts less than 457 mm in diameter.
- g. Piping suspended by individual hangers 300 mm or less in length from the top of pipe to the bottom of the supporting structural member where the hanger is attached, except as noted below.
- h. Ducts suspended by hangers 300 mm or less in length from the top of the duct to the bottom of the supporting structural member, except as noted below.

In exemptions g. and h. all hangers shall meet the length requirements. If the length requirement is exceeded by one hanger in the run, the entire run shall be braced.

#### 1.2.7 All Other Interior Piping, Conduit, and Ducts

Interior piping, conduit, and ducts not covered by paragraphs Exclusion or Pipes and Ducts Requiring No special Seismic Restraints shall be seismically protected in accordance with the provisions herein.

#### 1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The

following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

SD-01 Data

Bracing and Coupling; GA.  
Lighting Fixtures in Buildings; GA.  
Miscellaneous Equipment; GA.

Copies of the design calculations with the detail drawings. Calculations shall be stamped by a registered engineer and shall verify the capability of structural members to which bracing is attached for carrying the load from the brace.

SD-04 Drawings

Bracing and Coupling; FIO.  
Flexible Couplings or Joints; FIO.  
Resilient Vibration Isolation Devices; FIO.  
Lighting Fixtures in Buildings; FIO.  
Miscellaneous Equipment; FIO.

Detail drawings along with catalog cuts, templates, and erection and installation details, as appropriate, for the items listed. Submittals shall be complete in detail; shall indicate thickness, type, grade, class of metal, and dimensions; and shall show construction details, reinforcement, anchorage, and installation with relation to the building construction.

SD-13 Certificates

Flexible Ball Joints; FIO.

Flexible ball joints shall be certified to be suitable for the service intended by the manufacturer, based on not less than 2 years' satisfactory operation in a similar application.

2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Materials and equipment shall conform to the requirements specified below:

2.1.1 Bolts and Nuts

Squarehead and hexhead bolts, and heavy hexagon nuts, ASME B18.2.1, ASME B18.2.2, or ASTM A 307 for bolts and ASTM A 563 for nuts. Bolts and nuts used underground and/or exposed to weather shall be galvanized in accordance with ASTM A 153.

2.1.2 Sway Bracing

Material used for members listed in this section and on the drawings, shall be structural steel conforming with the following:

- a. Plates, rods, and rolled shapes, ASTM A 36.
- b. Wire rope, ASTM A 603.

- c. Tubes, ASTM A 500,
- d. Pipes, ASTM A 53,
- e. Light gauge angles, less than 6 mm thickness, ASTM A 653.

#### 2.1.3 Flexible Couplings

Flexible couplings shall have same pressure and temperature ratings as adjoining pipe specified in section 15400.

##### 2.1.3.1 Flexible Ball Joints

Flexible ball joints shall have cast or wrought steel casing and ball parts capable of 360-degree rotation plus not less than 15-degree angular movement.

##### 2.1.3.2 Flexible Mechanical Joints

- a. Mechanical couplings for steel or cast iron pipe shall be of the sleeve type and shall provide a tight flexible joint under all reasonable conditions, such as pipe movement caused by expansion, contraction, slight settling or shifting of the ground, minor variations in trench gradients, and traffic vibrations. Where permitted in other sections of these specifications, joints utilizing split-half couplings with grooved or shouldered pipe ends may be used.
- b. Sleeve-type couplings shall be used for joining plain-end pipe sections. The coupling shall consist of one steel middle ring, two steel followers, two gaskets, and necessary steel bolts and nuts to compress the gaskets. Underground bolts shall be high-strength type as specified above.

#### 2.1.4 Lighting Fixture Supports

Fixture supports shall be malleable iron. Lighting fixtures and supports shall conform to UL 1570 or UL 1571 as applicable.

### 3 EXECUTION

#### 3.1 BRACING AND COUPLING

Bracing and coupling shall conform to the arrangements shown. Provisions of this paragraph apply to all piping within a 1.5 m line around outside of building unless buried in the ground. Piping grouped for support on trapeze-type hangers shall be braced at the same intervals as determined by the smallest diameter pipe of the group. No trapeze-type hanger shall be secured with less than two 13 mm bolts. Bracing rigidly attached to pipe flanges, or similar, shall not be used where it would interfere with thermal expansion of piping.

#### 3.2 BUILDING DRIFT

Sway braces for a run shall not be attached to two dissimilar structural elements of a building that may respond differentially during an earthquake



unless a flexible joint is provided. Joints capable of accommodating seismic displacements shall be provided where pipes pass through a building seismic or expansion joint, or where rigidly supported pipes connect to equipment with vibration isolators. For threaded piping, swing joints shall be provided. For piping with manufactured ball joints the seismic drift shall be 0.015 meters per meter of height above the base where the seismic separation occurs; this drift value shall be used in place of the expansion given in the manufacturer's selection table.

### 3.3 FLEXIBLE COUPLINGS OR JOINTS

#### 3.3.1 Building Piping

Flexible couplings or joints in building piping shall be provided at bottom of all pipe risers larger than 90 mm in diameter. Flexible couplings or joints shall be braced laterally without interfering with the action of the flexible coupling or joint. Cast iron waste and vent piping need only comply with these provisions when caulked joints are used. Flexible bell and spigot pipe joints using rubber gaskets or no-hub fittings may be used at each branch adjacent to tees and elbows for underground waste piping inside of building to comply with these requirements.

### 3.4 PIPE SLEEVES

Pipe sleeves in interior non-fire rated walls shall be sized as indicated on the drawings to provide clearances that will permit differential movement of piping without the piping striking the pipe sleeve.

### 3.5 SPREADERS

Spreaders shall be provided between adjacent piping runs to prevent contact during seismic activity whenever pipe or insulated pipe surfaces are less than 100 mm apart. Spreaders shall be applied at same interval as sway braces at an equal distance between the sway braces. If rack type hangers are used where the pipes are restrained from contact by mounting to the rack, spreaders are not required for pipes mounted in the rack. Spreaders shall be applied to surface of bare pipe and over insulation on insulated pipes utilizing high-density inserts and pipe protection shields in accordance with the requirements of Section 15250 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

### 3.6 ANCHOR BOLTS

#### 3.6.1 Cast-In-Place

Floor or pad mounted equipment shall use cast-in-place anchor bolts, except as specified below. One nut shall be provided on each bolt. Anchor bolts shall conform to the following tabulation for the various equipment weights and specified seismic zone or the manufacturer's installation recommendations, whichever is the most stringent, unless otherwise shown on the drawings. Anchor bolts that exceed the normal depth of equipment foundation piers or pads shall either extend into concrete floor or the foundation shall be increased in depth to accommodate bolt lengths.

## 3.6.2 Minimum Bolt Sizes, Cast-In-Place Anchor Bolts

Maximum Equipment Weight (Kg)	Minimum Bolt Sizes (mm)*				
	Zone 4	Zone 3	Zone 2A	Zone 2B	Zone 1
225	13	13	13	13	13
450	13	13	13	13	13
2250	13	13	13	13	13
4500	13	13	13	13	13
9000	13	13	13	13	13
13500	16	13	13	1	13
22500	22	16	13	13	13
45000	**	**	16	22	13

\*Based on four bolts per item, a minimum embedment of 12 bolt diameters, a minimum bolt spacing of 16 bolt diameters and a minimum edge distance of 12 bolt diameters. Equivalent total cross-sectional area shall be used when more than four bolts per item are provided. Anchor bolts shall conform to ASTM A 307. Anchor bolts shall have an embedded straight length equal to at least 12 times nominal diameter of the bolt.

\*\*Equipment weighing more than 22,500 kg in Zones 3 and 4 shall have at least six bolts per item.

## 3.6.3 Expansion or Chemically Bonded Anchors

Expansion or chemically bonded anchors shall not be used unless test data in accordance with ASTM E 488 has been provided to verify the adequacy of the specific anchor and application. The expansion anchor size shall be not less than that required in paragraph Minimum Bolt Sizes, Cast-In-Place Anchor Bolts. Expansion and chemically bonded anchors shall be installed in accordance with the manufacturer's recommendations. The allowable forces shall be adjusted for the spacing between anchor bolts and the distance between the anchor bolt and the nearest edge, as specified by the manufacturer.

## 3.6.3.1 General Testing

Expansion and chemically bonded anchors shall be tested in place after installation. The tests shall occur not more than 24 hours after installation of the anchor and shall be conducted by an independent testing agency; testing shall be performed on random anchor bolts as described below.

## 3.6.3.2 Torque Wrench Testing

Torque wrench testing shall be done on not less than 50 percent of the total installed expansion anchors and at least one anchor for every piece of equipment containing more than two anchors. The test torque shall equal the minimum required installation torque as required by the bolt manufacturer. Torque wrenches shall be calibrated at the beginning of each day the torque tests are performed. Torque wrenches shall be recalibrated for each bolt diameter whenever tests are run on bolts of various diameters. The applied torque shall be between 20 and 100 percent of wrench capacity. The test torque shall be reached within one half turn of the nut, except for 9 mm

sleeve anchors which shall reach their torque by one quarter turn of the nut. If any anchor fails the test, similar anchors not previously tested shall be tested until 20 consecutive anchors pass. Failed anchors shall be retightened and retested to the specified torque; if the anchor still fails the test it shall be replaced.

#### 3.6.3.3 Pullout Testing

Expansion and chemically bonded anchors shall be tested by applying a pullout load using a hydraulic ram attached to the anchor bolt. At least 5 percent of the anchors, but not less than three per day shall be tested. The load shall be applied to the anchor without removing the nut; when that is not possible, the nut shall be removed and a threaded coupler shall be installed of the same tightness as the original nut. The test setup shall be checked to verify that the anchor is not restrained from withdrawing by the baseplate, the test fixture, or any other fixtures. The support for the testing apparatus shall be at least 1.5 times the embedment length away from the bolt being tested. Each tested anchor shall be loaded to 1 times the design tension value for the anchor. The anchor shall have no observable movement at the test load. If any anchor fails the test, similar anchors not previously tested shall be tested until 20 consecutive anchors pass. Failed anchors shall be retightened and retested to the specified load; if the anchor still fails the test it shall be replaced.

### 3.7 RESILIENT VIBRATION ISOLATION DEVICES

Selection of anchor bolts for vibration isolation devices and/or snubbers for equipment base and foundations shall follow the same procedure as in paragraph ANCHOR BOLTS except that an equipment weight equal to five times the actual equipment weight shall be used.

#### 3.7.1 Resilient and Spring-Type Vibration Devices

Vibration isolation devices shall be selected so that the maximum movement of equipment from the static deflection point shall be 15 mm.

#### 3.7.2 Multidirectional Seismic Snubbers

Multidirectional seismic snubbers employing elastomeric pads shall be installed on all floor- or slab-mounted equipment. These snubbers shall provide 6 mm free vertical and horizontal movement from the static deflection point. Snubber medium shall consist of multiple pads of cotton duct and neoprene or other suitable materials arranged around a flanged steel trunnion so both horizontal and vertical forces are resisted by the snubber medium.

### 3.8 SWAY BRACES FOR PIPING

Sway braces shall be provided to prevent movement of the pipes under seismic loading. Braces shall be provided in both the longitudinal and transverse directions, relative to the axis of the pipe. The bracing shall not interfere with thermal expansion requirements for the pipes as described in other sections of these specifications.

## 3.8.1 Transverse Sway Bracing

Transverse sway bracing for steel and copper pipe shall be provided at intervals not to exceed those given in the tabulation below as modified for each seismic zone. All runs shall have a minimum of two transverse braces. Transverse sway bracing for pipes of materials other than steel and copper shall be provided at intervals not to exceed the hanger spacing as specified in Section 15400 PLUMBING, GENERAL PURPOSE.

## 3.8.2 Longitudinal Sway Bracing

Longitudinal sway bracing shall be provided at 12 m intervals except when the location of sway braces is shown on the drawings for the particular piping system. All runs shall have one longitudinal brace minimum. Sway braces shall be constructed in accordance with the drawings. Branch lines, walls, or floors shall not be used as sway braces.

## 3.8.3 Vertical Runs

Vertical runs of piping shall be braced at not more than 3 m vertical intervals. For tubing, bracing shall be provided at no more than 1.2 m spacing. Vertical braces shall be above the center of gravity of the span being braced. All sway braces shall be constructed in accordance with the drawings. Branch lines, walls, or floors shall not be used as sway braces.

## 3.8.4 Anchor Rods, Angles, and Bars

Anchor rods, angles, and bars shall be bolted to either pipe clamps or pipe flanges at one end and cast-in-place concrete or masonry insert or clip angles bolted to the steel structure on the other end. Rods shall be solid metal or pipe as specified below. Anchor rods, angles, and bars shall not exceed lengths given in the tabulation below.

## 3.8.5 Maximum Length for Anchor Braces

Type	Size (millimeters)	Maximum Length* (meters)	Allowable Loads* (kilonewtons)
Angles	38 x 38 x 6	1.5	25.5
	50 x 50 x 6	2.0	34.5
	64 x 38 x 6	2.5	43.5
	75 x 64 x 6	2.5	48.0
	75 x 75 x 6	3.0	53.0
Rods	91	1.0	16.5
	22	1.0	22.0
Flat Bars	38 x 6	0.4	14.0
	50 x 6	0.4	18.0
	50 x 10	0.5	28.5
Pipes (40s)	25	2.0	18.0
	32	2.8	24.5
	40	3.2	29.5
	50	4.0	39.5

\*Based on the slenderness ratio of  $l/r = 200$  and ASTM A 36 steel, where  $l$  is the length of the brace and  $r$  is the least radius of gyration of the brace.

#### 3.8.6 Clamps and Hangers

Clamps or hangers on uninsulated pipes shall be applied directly to pipe. Insulated piping shall have clamps or hangers applied over insulation in accordance with Section 15250 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

#### 3.8.7 Bolts

Bolts used for attachment of anchors to pipe and structure shall be not less than 13 mm (1/2 inch) diameter.

### 3.9 SWAY BRACES FOR DUCTS

#### 3.9.1 Braced Ducts

Bracing details and spacing for rectangular and round ducts shall be in accordance with SMACNA-12, including Appendix E, using Seismic Hazard Level C.

#### 3.9.2 Unbraced Ducts

Hangers for unbraced ducts shall be positively attached to the duct within 50 mm of the top of the duct with a minimum of two #10 sheet metal screws. Unbraced ducts shall be installed with a 150 mm minimum clearance to vertical ceiling hanger wires.

#### 3.10 SWAY BRACES FOR CONDUIT

Conduit shall be braced as for an equivalent weight pipe.

#### 3.11 EQUIPMENT SWAY BRACING

##### 3.11.1 Suspended Equipment

Equipment sway bracing shall be provided for items supported from overhead floor or roof structures. Braces shall consist of angles, rods, wire rope, bars, or pipes arranged as shown and secured at both ends with not less than 13 mm bolts. Braces shall conform to paragraph Maximum Length for Anchor Braces. Sufficient braces shall be provided for equipment to resist a horizontal force equal to 0.28 times the weight of equipment without exceeding safe working stress of bracing components. Details of equipment bracing shall be submitted for approval. In lieu of bracing with vertical supports, these items may be supported with hangers inclined at 45 degrees directed up and radially away from equipment and oriented symmetrically in 90-degree intervals on the horizontal plane, bisecting the angles of each corner of the equipment, provided that supporting members are properly sized to support operating weight of equipment when hangers are inclined at a 45-degree angle.

### 3.11.2 Floor or Pad Mounted Equipment

#### 3.11.2.1 Shear Resistance

Floor mounted equipment shall be bolted to the floor. Requirements for the number and installation of bolts to resist shear forces shall be in accordance with paragraph ANCHOR BOLTS.

#### 3.11.2.2 Overturning Resistance

The ratio of the height of the equipment (measured from the base to the center of gravity of the equipment) to the minimum distance between anchor bolts shall be used to determine if overturning forces need to be considered in the sizing of anchor bolts. If this ratio is greater than 8.89 the bolt values in paragraph Minimum Bolt Sizes, Cast-In-Place Anchor Bolts shall not be used and calculations shall be provided to verify the adequacy of the anchor bolts for combined shear and overturning.

### 3.12 MISCELLANEOUS EQUIPMENT

#### 3.12.1 Rigidly Mounted Equipment

The following specific items of equipment to be furnished under this contract shall be constructed and assembled to withstand a horizontal lateral force of 0.06 times the operating weight of the equipment, at vertical center of gravity of the equipment without causing permanent deformation, dislocations, separation of components, or other damage, which would render the equipment inoperative for significant periods of time following an earthquake.

##### Rigidly Mounted Equipment

Boilers  
Engine-Generators  
Substations  
Transformers  
Switch Boards and Switch Gears  
Motor Control Centers  
Free Standing Electric Motors  
Surge Tanks  
Chilled and Hot Water Storage Tanks  
Expansion Tanks

#### 3.12.2 Nonrigid or Flexibly-Mounted Equipment

The following specific items of equipment to be furnished shall be constructed and assembled to resist a horizontal lateral force of 0.3 times the operating weight of the equipment at the vertical center of gravity of the equipment.

### 3.13 LIGHTING FIXTURES IN BUILDINGS

Lighting fixtures and supports shall conform to the following:

### 3.13.1 Pendant Fixtures

Loop and hook or swivel hanger assemblies for pendant fixtures shall be fitted with a restraining device to hold the stem in the support position during earthquake motions. Pendant-supported fluorescent fixtures shall also be provided with a flexible hanger device at the attachment to the fixture channel to preclude breaking of the support. The motion of swivels or hinged joints shall not cause sharp bends in conductors or damage to insulation.

### 3.13.2 Recessed Fluorescent Fixtures

Recessed fluorescent individual or continuous-row mounted fixtures shall be supported by a seismic-resistant suspended ceiling support system and shall be fastened thereto at each corner of the fixture with bolts or approved clips; or shall be provided with fixture support wires attached to the building structural members using two wires for individual fixtures, attached to opposite corners, and one wire per unit of continuous row mounted fixtures. Each wire support shall be capable of supporting four times the weight of the fixture. Recessed lighting fixtures not over 25 kg in weight and suspended or pendant-hung fixtures not over 10 kg in weight may be supported by and attached directly to the ceiling system runners by a positive attachment such as screws or bolts, number and size as required by design seismic zone. Fixture accessories, including louvers, diffusers, and lenses shall have lock or screw attachments.

### 3.13.3 Assembly Mounted on Outlet Box

A supporting assembly that is intended to be mounted on an outlet box shall be designed to accommodate mounting features on 100 mm boxes, 75 mm plaster rings, and fixture studs.

### 3.13.4 Surface-Mounted Fluorescent Fixtures

Surface-mounted fluorescent individual or continuous-row fixtures shall be attached to a seismic-resistant ceiling support system. Fixture support devices for attaching to suspended ceilings shall be a locking-type scissor clamp or a full loop band that will securely attach to the ceiling support. Fixtures attached to underside of a structural slab shall be properly anchored to the slab at each corner of the fixture.

### 3.13.5 Wall-Mounted Emergency Light Unit

Each wall-mounted emergency light unit shall be secured to remain in place during a seismic disturbance.

### 3.13.6 Lateral Force

Light fixture bracing shall be designed to resist a lateral force of 0.28 times the fixture weight.

## 3.14 SUSPENDED CEILING ASSEMBLIES

The structural members of ceiling support systems, used primarily to support acoustical tile panels or acoustical panel lay-in tiles, with or without lighting fixtures, ceiling-mounted air terminals, and ceiling-mounted services, shall conform to the following:

### 3.14.1 Design Loads

The main runners and cross-runners and their splices and intersection connections shall be designed for two times the design load or ultimate axial tension or compression (minimum 550 N. The connections at the splices and intersections shall be of a mechanical interlocking type that cannot easily be disengaged. Ceiling structural systems shall be designed to withstand required vertical load as well as a lateral force of 30 or 11.3 percent of the ceiling weight. The ceiling weight shall include all lighting fixtures and other equipment that are laterally supported by the ceiling and shall be not less than 200 Pa . Exception: Ceiling areas of 13 square meters or less surrounded by walls that connect directly to the structure above will be exempt from the lateral-load standards of this specification.

### 3.14.2 Installation Requirements

Installation requirements shall be in accordance with ASTM E 580 except as follows:

#### 3.14.2.1 Vertical Support

Hanger wires supporting a maximum tributary ceiling area of 1.5 square meters shall be a minimum of 10 gauge in diameter. The size of wires supporting a tributary ceiling area greater than 1.5 square meters shall be substantiated by design calculations. Hanger attachment devices used in ceiling systems not exceeding 200 Pa shall be capable of supporting a minimum allowable load of 1.3 kN. Hanger attachment devices used in ceiling systems exceeding 200 Pa shall be capable of supporting the design load and shall be substantiated by design calculations. If hangers must be splayed more than one horizontal to six vertical, the resulting horizontal force shall be offset by bracing or counter-splaying, and substantiated by design calculations.

#### 3.14.2.2 Lateral Support

In lieu of the design criteria stated above, where ceiling loads do not exceed 200 Pa, lateral support for the ceiling system may be provided by four galvanized wires of minimum No. 12 gauge, as indicated in ASTM E 580, paragraph 4.4.6.

### 3.14.3 Lighting Fixture and Air Diffuser Supports

Lighting fixture and air diffuser supports shall be designed and installed to meet the requirements of equipment supports in the preceding paragraphs of this specification with the following exceptions:

- a. Recessed lighting fixtures not over 25 kg in weight and suspended and pendent-hung fixtures not over 10 kg in weight may be supported and attached directly to the ceiling system runners by a positive attachment such as screws or bolts.
- b. Air diffusers that weigh not more than 10 kg and that receive no tributary loading from ductwork may be positively attached to and supported by the ceiling runners.



## SECTION 13100

## PREFABRICATED BRIDGES

## 1 GENERAL

## 1.1 SCOPE

These specifications are for a fully engineered clear span bridge of steel construction and shall be regarded as minimum standards for design and construction.

## 1.2 GENERAL REQUIREMENTS

| Qualified suppliers must have at least 5 years experience fabricating these  
| type structures.

## 1.2.1 Acceptable Manufacturers

Continental Bridge  
8301 State Highway 29 North  
Alexandria, Minnesota 56308  
1-800-328-2047

## 1.2.2 Manufacturers Approved As Equal.

The contractor shall provide the following documentation, for any proposed supplier:

## 1.2.2.1 Product Literature

1. All documentation to insure the proposed substitution will be in compliance with these specifications. This shall include:

Representative design calculations  
Representative drawings  
Splicing and erection procedures  
Warranty information  
Inspection and Maintenance procedures  
AISC Shop Certification  
Welder Qualifications

2. Proposed suppliers shall have at least five (5) years experience designing and fabricating these type structures and a minimum of five (5) successful bridge projects, of similar construction, each of which has been in service at least three (3) years. List the location, bridge size, owner, and a contact for reference for each project.

## 1.3 WARRANTY

The bridge manufacturer shall warrant their structure(s) to be free of design, material and workmanship defects for a period of fifteen (15) years from the date of delivery. Naturally durable hardwood decking and wood attachments shall carry a fifteen-year warranty against rot, termite damage, of fungal decay. Other types of wood are excepted under this warranty.

This warranty shall not cover defects in the bridge caused by abuse, misuse, overloading, accident, improper maintenance, alteration or any other cause not the result of defective materials or workmanship.

This warranty shall be void unless owner records can be supplied which will indicate compliance with the minimum guidelines specified in the Inspection and Maintenance Procedures.

Repair or replacements shall be the exclusive remedy for defects under this warranty. The bridge manufacturer shall not be liable for any consequential or incidental damages for breach of any express or implied warranty on their structures.

#### 1.4 SUBMITTALS

##### SD-01 Data

Pre-engineered/Prefabricated Bridges; FIO.

Product Data: Provide manufacturer's specifications, standard details, and installation requirements.

Structural Calculations; GA.

Structural calculations for the bridge superstructure shall be submitted by the bridge manufacturer and reviewed by the approving engineer. All calculations shall be signed and sealed by a Professional Engineer who is licensed in accordance with Section 3.0. The calculations shall include all design information necessary to determine the structural adequacy of the bridge.

The calculations shall include the following:

All AISC allowable stress checks for axial, bending and shear forces in the critical member of each truss member type (i.e. top chord, bottom chord, floor beam, vertical, etc.)

Checks for the critical connection failure modes for each truss member type (i.e. vertical, diagonal, floor beam, etc.). Special attention shall be given to all welded tube on tube connections (see section 3.3.2 for design check requirements).

All bolted splice connections.

Main truss deflection checks.

U-Frame stiffness checks (used to determine K factors for out-of-plane buckling of the top chord) for all half through or "pony" truss bridges.

Concrete deck design (if applicable).

The analysis and design of triangulated truss bridges shall account for moments induced in members due to joint fixity where applicable. Moments due to both truss deflection and joint eccentricity must be considered.

## SD-04 Drawings

Pre-engineered/Prefabricated Bridges; GA.

Schematic drawings and diagrams shall be submitted to the customer for their review after receipt of order. Submittal drawings shall be unique drawings, prepared to illustrate the specific portion of the work to be done. All relative design information such as member sizes, bridge reactions, and general notes shall be clearly specified on the drawings. Drawings shall have cross referenced details and sheet numbers. All drawings shall be signed and sealed by a Professional Engineer who is licensed in accordance with Section 3.0.

## SUBMITTAL DRAWINGS

Data Required to be Shown:

- \_\_\_\_\_ Bridge Elevation
- \_\_\_\_\_ Bridge Cross Section
- \_\_\_\_\_ All Member Sizes
- \_\_\_\_\_ All Vertical Truss Members are Square or Rectangular Tubing
- \_\_\_\_\_ Bridge Reactions
- \_\_\_\_\_ General Notes Indicating
- \_\_\_\_\_ AISC Stress Conformance
- \_\_\_\_\_ Material Specifications to be Followed
- \_\_\_\_\_ Design Live Load
- \_\_\_\_\_ Design Vehicle Load (If Applicable)
- \_\_\_\_\_ Design Wind Load
- \_\_\_\_\_ Other Specified Design Loads
- \_\_\_\_\_ Welding Process
- \_\_\_\_\_ Blast Cleaning
- \_\_\_\_\_ Paint System to be Used (If Applicable)
- \_\_\_\_\_ Paint Color Chart (If Applicable)
- \_\_\_\_\_ Detailed Bolted Splices (If Applicable)
- \_\_\_\_\_ Signature and Seal of Professional Engineer, licensed in accordance with Section 3.0

## SD-08 Statements

Welder Qualifications; FIO.

Welder certifications shall be in compliance with AWS standard qualification tests. Welding procedures shall be in compliance with Section 5.1.

## SD-09 Reports

Pre-engineered/Prefabricated Bridges; GA.

## DESIGN CALCULATIONS

## Data Required to be Shown:

- \_\_\_\_\_ Data Input for 3-D Analysis of Bridge
- \_\_\_\_\_ Joint Coordinates & Member Incidences
- \_\_\_\_\_ Joint and Member Loads
- \_\_\_\_\_ Member Properties
- \_\_\_\_\_ Load Combinations
- \_\_\_\_\_ AISC Member Stress Checks for Each Member Type
- \_\_\_\_\_ Critical Connection Failure Mode Checks For Each Member Type
- \_\_\_\_\_ Chord Face Plastification Checks
- \_\_\_\_\_ Punching Shear Checks
- \_\_\_\_\_ Material Failure Checks (Truss Webs)
- \_\_\_\_\_ Weld Failure Checks (Effective Length)
- \_\_\_\_\_ Local Buckling of the Main Member Face Checks
- \_\_\_\_\_ Main Member Yielding Failure Checks
- \_\_\_\_\_ Main Member Crippling Failure Checks
- \_\_\_\_\_ Main Member Buckling Failure Checks
- \_\_\_\_\_ Main Member Shear Failure Checks
- \_\_\_\_\_ Bolted Splice Location (if applicable)
- \_\_\_\_\_ All Bolted Splice Checks (if applicable)
- \_\_\_\_\_ Main Truss Deflection Checks
- \_\_\_\_\_ Decking Material Checks
- \_\_\_\_\_ U-Frame Stiffness Checks (If "Pony" Truss)
- \_\_\_\_\_ Interior and End Portal Design Checks (if "Box" Truss)
- \_\_\_\_\_ Determination of Top Chord K Factor Based on "U-Frame" Stiffness (If "Pony" Truss)
- \_\_\_\_\_ Consideration of Individual Member Moments Due to Truss Deflection, Joint Fixity and Joint Eccentricity

## FABRICATION SUBMITTALS

## Data Required to be Submitted:

- \*\*\* \_\_\_\_\_ Written Installation Instructions
- \*\*\* \_\_\_\_\_ Written Splicing Instructions
- \*\*\* \_\_\_\_\_ Written Maintenance & Inspection Instructions
- \*\*\* \_\_\_\_\_ Welder Certifications
- \*\*\* \_\_\_\_\_ Welding Procedures
- \_\_\_\_\_ Material Certifications (if applicable)
- \_\_\_\_\_ Structural Steel (if applicable)
- \_\_\_\_\_ Decking (if applicable)
- \_\_\_\_\_ Structural Bolts (if applicable)
- \*\*\* \_\_\_\_\_ Quality Control Section of AISC Certification Manual (if applicable)
- \*\*\* \_\_\_\_\_ Painter Certifications (If Applicable)
- \_\_\_\_\_ Weld Testing Reports (If Applicable)

\*\*\* Note: These items are required to be submitted along with Submittal Drawings and Design Calculations. Those Production Submittal Items not marked are required to be submitted prior to shipping of bridge.

## SD-13 Certificates

Pre-engineered/Prefabricated Bridges; FIO.

Certificates stating that the bridges are certified conforming to requirements of this section. Labels or markings permanently affixed to the window will be accepted in lieu of certificates.

## 2 PRODUCTS

## 2.1 STEEL

## 2.1.1 Unpainted Steel

Bridges which are not to be painted shall be fabricated from high strength, low alloy, atmospheric corrosion resistant ASTM A847 cold-formed welded square and rectangular tubing and/or ASTM A588, or ASTM A242, ASTM A606 plate and structural steel shapes ( $F_y = 344 \text{ mPa (50 ksi)}$ ). The minimum corrosion index of atmospheric corrosion resistant steel, as determined in accordance with ASTM G101, shall be 5.8.

## 2.2 DECKING

## 2.2.1 Wood Decking

## 2.2.1.1 Type of Wood Decking

Wood decking shall be naturally durable hardwood Ipe (*Tabebuia* Spp) Lapacho Group or Cumaru (*Dipteryx Odorta*). All planks shall be partially air dried to a moisture content of 15% to 20%, and shall be supplied S4S (surfaced four sides), E4E (eased four edges), with the edges eased to a radius of 3 mm. Measured at 30% moisture content, the width and thickness shall not vary from specified dimensions by more than  $\pm 0.04$  inches. All planks shall be supplied with the end sealed with "Anchorseal" Mobil CER-M or an equal aqueous wax log sealer.

All planks shall be graded as per Iron Woods™ FEQ-CAH (First Export Quality -Clear All Heart) grading rules, defined as follows:

1. Lumber shall be graded both faces and both edges.
2. Lumber shall be straight grained and parallel cut without heart center.
3. Lumber shall be all heartwood, no sapwood allowed.
4. Lumber shall be in sound condition, free from wormholes or knots.
5. Allowable Imperfections are: Natural drying checks, Discoloration caused by weathering or chemical reaction, Bow or Spring which can be removed using normal installation methods and tools.
6. Imperfections Not Allowed: Longitudinal heart cracks, Internal cracks, Firm or soft sap wood, Fungi Affects (blue to gray, brown to red, white to yellow, or incipient decay), Deformation (twisting or cupping) which cannot be removed using normal installation methods and tools.

All planks shall meet or exceed the following mechanical properties (based on the 2" standard) as defined by the U.S. Forest Products Laboratory publications and testing data:

MC%: 12%  
 Bending Strength: 188,030 kPa  
 Modulus of Elasticity: 20,892 mPa  
 Max. Crush Strength: 94,600 kPa

Janka side hardness is 1,606 kg at 12% moisture content.

Average air-dry density is 993 to 1,297 kg/cubic meter.  
 Basic specific gravity is 0.80 - 0.91.

All planks shall be naturally fire resistant without the use of any fire resistant preservatives to meet NFPA Class A and UBC Class I.

Planks shall be supplied that meet or exceed the Static Coefficient of Friction for both Neolite and leather shoes in accordance with ASTM Test Method C1028-89.

FORCE IN kg

SHOE MATERIAL	DRY	WET
Neolite	0.33	0.31
Leather	0.25	0.36

For transverse wood decking, wheel loads shall be assumed to act on one plank only. The wheel loads shown in Section 3.1.3 shall be distributed on the plank along a length equal to the tire print width (W). The plank shall be designed for shear and bending in accordance with the support conditions and spacing. For design, the following unfactored allowable values shall be used:

Allowable Bending	=	25,511 kPa
Allowable Shear	=	2,206 kPa
Modulus of Elasticity	=	20,685 mPa

#### 2.2.1.2 Wood Decking Attachment

At time of installation, planks are to be placed tight together with no gaps.

Every plank must be attached to at least one support with at least one fastener.

Fasteners to be zinc plated bolts. Hex-head bolts, with a steel plank hold-down, are to be used at the ends of planks. Carriage bolts are to be used as interior connection fasteners. Power actuated fasteners will not be allowed.

Planks are to be drilled prior to installation of bolts.

In addition to at least one fastener at either end of every plank (typical for all installations), planks for bridges with widths of 2 438 mm to 3 048 mm are to receive a minimum of one interior connection bolt at a stringer location approximately near the center of the bridge width. Bridges wider

than 3 048 mm are to have interior connection bolts located at a minimum of two interior stringer locations, approximately located at the third points of the bridge width.

Use of the wood decking to provide lateral support for design of the stringers shall not be allowed.

### 3 EXECUTION

#### 3.1 GENERAL FEATURES OF DESIGN

Span(s): Bridge spans shall be one (1) at 12 meters and one (1) at 6.4 meters (straight line dimension) and shall be as measured from each end of the bridge structure.

Width(s): Bridge width shall be 2.5 meters and shall be as measured from the inside face of structural elements at deck level.

Bridge type(s): Bridge(s) shall be designed as a half-through "Pratt" truss with two (2) diagonals per panel and sloped end vertical members. Interior vertical members shall be perpendicular to the chord faces. Bridges shall be designed utilizing an underhung floor beam (top of floorbeam welded to the bottom of the bottom chord).

Finishes: Steel members shall be composed of weathering steel as described herein.

Deck: Deck shall be wood planks as described herein.

The distance from the top of the deck to the top and bottom truss members shall be determined by the bridge manufacturer based upon structural and/or shipping requirements.

The top of the top chord shall not be less than 1 067 mm above the deck (measured from the high point of the deck) on bridges used for pedestrian traffic.

#### 3.2 MEMBER COMPONENTS

All members of the vertical trusses (top and bottom chords, verticals, and diagonals) shall be fabricated from square and/or rectangular structural steel tubing. Other structural members and bracing shall be fabricated from structural steel shapes or square and rectangular structural steel tubing.

To provide lateral support for the top flange of open shape stringers (w-shapes or channels), a minimum of one stiffener shall be provided in each stringer at every floor beam location.

#### 3.3 ATTACHMENTS

##### 3.3.1 Safety Rails

Horizontal safety rails shall be placed on the structure up to a minimum height of 1 067 mm above the deck surface. Safety rails shall be placed so as to prevent a 100 mm sphere from passing through the truss. Safety rails shall be 32 mm x 32 mm x 3 mm angles, welded to the inside or outside of the structure at the bridge fabricators option. If placed inside the truss, the

safety rails shall have a maximum span of 1 727 mm, measured from centerline to centerline of support post or truss vertical. If placed outside the structure, this maximum span may be increased to 1 981 mm. Safety rails placed on the inside of the truss shall have their ends sealed and ground smooth so as to produce no sharp edges.

The safety rail system shall be designed for an infill loading of 976 kg, applied horizontally at right angles, to a one square meter area at any point in the system.

### 3.4 CAMBER

The bridge shall have a vertical camber dimension at midspan equal to 100% of the full dead load deflection plus 1% of the full length of the bridge.

### 3.5 ELEVATION DIFFERENCE

The bridge abutments shall be constructed at the same elevation on both ends of the bridge.

### 3.6 ENGINEERING

Structural design of the bridge structure(s) shall be performed by or under the direct supervision of a licensed professional engineer and done in accordance with recognized engineering practices and principles. The engineer shall be licensed in the locality of the project.

### 3.7 DESIGN LOADS

In considering design and fabrication issues, this structure shall be assumed to be statically loaded. No dynamic analysis shall be required nor shall fabrication issues typically considered for dynamically loaded structures be considered for this bridge.

#### 3.7.1 Dead Load

The bridge structure shall be designed considering its own dead load (superstructure and decking) only. No additional dead loading need be considered.

#### 3.7.2 Uniform Live Load

##### 3.7.2.1 Pedestrian Live Load

Main Members: Main supporting members, including girders, trusses and arches shall be designed for a pedestrian live load of 415 kg per square meter of bridge walkway area. The pedestrian live load shall be applied to those areas of the walkway so as to produce maximum stress in the member being designed.

#### 3.7.3 Vehicle Load

##### 3.7.3.1 Maintenance Vehicle

Bridge shall be designed for an occasional single maintenance vehicle load of 4,536 kg. The load shall be distributed as a four-wheel vehicle with 80% of the load on the rear wheels. The maintenance vehicle load shall not be



placed in combination with the pedestrian load. A vehicle impact allowance is not required.

#### 3.7.4 Wind Load

##### 3.7.4.1 Horizontal Forces

The bridge(s) shall be designed for a wind load of 171 kg/sq. meter on the full vertical projected area of the bridge as if enclosed. The wind load shall be applied horizontally at right angles to the longitudinal axis of the structure.

The wind loading shall be considered both in the design of the lateral load bracing system and in the design of the truss vertical members and their connections.

##### 3.7.4.2 Overturning Forces

The effect of forces tending to overturn structures shall be calculated assuming that the wind direction is at right angles to the longitudinal axis of the structure. In addition, an upward force shall be applied at the windward quarter point of the transverse superstructure width. This force shall be 98 kg/sq. meter of deck.

#### 3.7.5 Snow Load

The bridge shall be designed for 24 kg/sq. meter snow load.

#### 3.7.6 Top Chord Railing Loads

The top chord, truss verticals, and floor beams shall be designed for lateral wind loads (per section 3.1.4.1) and for any loads required to provide top chord stability as outlined in Section 3.3.6; however, in no case shall the load be less than 74.4 kg/ lineal meter or a 91 kg point load, whichever produces greater stresses, applied in any direction at any point along the top chord.

#### 3.7.7 Load Combinations

The loads listed herein shall be considered to act in the following combinations, whichever produce the most unfavorable effects on the bridge superstructure or structural member concerned.

[DL=Dead Load; LL = Live Load; WL = Wind Load; VEH = Vehicle Load]

DL + LL

DL + VEH

DL+WL

DL+LL+WL

DL+VEH+.3WL

NOTE: Allowable stresses may be increased 1/3 above the values otherwise provided when produced by wind loading, acting alone or in combination with the design dead and live loads.

It shall be the responsibility of the foundation engineer to determine load combinations for design of the abutments.

### 3.8 DESIGN LIMITATIONS

#### 3.8.1 Deflection

##### 3.8.1.1 Vertical Deflection

The vertical deflection of the structure due to service pedestrian live load or applied vehicle load shall not exceed  $L/500$  of the span.

##### 3.8.1.2 Horizontal Deflection

The horizontal deflection of the structure due to lateral loads shall not exceed  $L/500$  of the span.

The service pedestrian live load shall be 415 kg/sq. meter.

Deflection limits due to occasional vehicular traffic shall not be considered.

#### 3.8.2 Minimum Thickness of Metal

The minimum thickness of all structural steel members shall be 6 mm nominal and be in accordance with the AISC Manual of Steel Construction's "Standard Mill Practice Guidelines". For ASTM A500 and ASTM A847 tubing, the section properties used for design shall be per the Steel Tube Institute of North America's Hollow Structural Sections "Dimensions and Section Properties".

### 3.9 GOVERNING DESIGN CODES / REFERENCES

Structural members shall be designed in accordance with recognized engineering practices and principles as follows:

1. American Association of State Highway and Transportation Officials (AASHTO).
2. American Institute of Steel Construction (AISC)
3. American National Standards Institute
4. American Welding Society (ANSI/AWS)

#### 3.9.1 Structural Steel Allowable Stresses

Allowable Design Stresses shall be in accordance with the "Standard Specifications for Highway Bridges" latest edition (AASHTO).

#### 3.9.2 Welded Tubular Connections

All welded tubular connections shall be checked, when within applicable limits, for the limiting failure modes outlined in the ANSI/AWS D1.1 Structural Welding Code or in accordance with the "Design Guide for Hollow Structural Section Connections" as published by the Canadian Institute of Steel Construction (CISC).

When outside the "validity range" defined in these design guidelines, the following limit states or failure modes must be checked:

Chord face plastification  
Punching shear (through main member face)  
Material failure  
Tension failure of the web member  
Local buckling of a compression web member  
Weld failure (based on effective lengths)  
Local buckling of a main member face  
Main member failure:  
Web or sidewall yielding  
Web or sidewall crippling  
Web or sidewall buckling  
Overall shear failure

All tubular joints shall be plain unstiffened joints (made without the use of reinforcing plates) except as follows:

1. Floor beams hung beneath the lower chord of the structure may be constructed with or without stiffener (or gusset) plates, as required by design.
2. Floor beams which frame directly into the truss verticals (H-Section bridges) may be designed with or without end stiffening plates as required by design.
3. Where chords, end floor beams and in high profiles the top end struts weld to the end verticals, the end verticals (or connections) may require stiffening to transfer the forces from these members into the end vertical.
4. Truss vertical to chord connections.

### 3.9.3 Wood

American Institute of Timber Construction (AITC)

Wood Handbook : Wood as an Engineering Material  
(by: US Forest Products Laboratory)

Tropical Timbers of the World: by US Forest Products Laboratory  
Sawn Lumber shall be designed in accordance with the procedures for sawn lumber as detailed in the "Timber Construction Manual."

### 3.9.4 Top Chord Stability

Structural Stability Research Council (SSRC), formerly Column Research Council.

The top chord of a half-through truss shall be considered as a column with elastic lateral supports at the panel points. The critical buckling force of the column, so determined, shall exceed the maximum force from dead load and live load (uniform or vehicular) in any panel of the top chord by not less than 50 percent for parallel chord truss bridges or 100 percent for tied arch bridges. The design approach to prevent top chord buckling shall be as outlined by E.C. Holt's research work in conjunction with the Column Research Council on the stability of the top chord of a half-through truss. See Appendix A for the calculation of the spring constant C and the determination of an appropriate K factor for out-of-plane buckling.

In addition, for the dead load plus vehicle load combination, the spring constant "C" furnished by the transverse "U-Frames" shall not be less than "C" required as defined by:

$$C \text{ required} = \frac{1.46P_c}{L}$$

where  $P_c$  is the maximum top chord compression due to dead load plus the vehicle load times the appropriate safety factor (1.5 for parallel chord truss bridges or 2.0 for tied arch truss bridges) and L is the length in inches of one truss panel or bay.

For uniformly loaded bridges, the vertical truss members, the floor beams and their connections (transverse frames) in half-through truss spans shall be proportioned to resist a lateral force of not less than 1/100k times the top chord compressive load, but not less than .004 times that top chord load, applied at the top chord panel points of each truss. The top chord load is determined by using the larger top chord axial force in the members on either side of the "U-frame" being analyzed. For end frames, the same concept applies except the transverse force is 1% of the axial load in the end post member.

For bridges with vehicle loads, the lateral force applied at the top chord elevation for design of the transverse frames shall not be less than 1% of the top chord compression due to dead load plus any vehicle loading.

The bending forces in the transverse frames, as determined above, act in conjunction with all forces produced by actual bridge loads as determined by an appropriate analysis.

### 3.10 WELDING

#### 3.10.1 Welding

Welding and weld procedure qualification tests shall conform to the provisions of ANSI/AWS D1.1 "Structural Welding Code", 1996 Edition. Filler metal shall be in accordance with the applicable AWS Filler Metal Specification (i.e. AWS A 5.28 for the GMAW Process). For exposed, bare, unpainted applications of corrosion resistant steels (i.e. ASTM A588 and A847), the filler metal shall be in accordance with AWS D1.1, Section 3.7.3.

#### 3.10.2 Welders

Welders shall be properly accredited operators, each of whom shall submit certification of satisfactorily passing AWS standard qualification tests for all positions with unlimited thickness of base metal, have a minimum of 6 months experience in welding tubular structures and have demonstrated the ability to make uniform sound welds of the type required.

### 3.11 GENERAL REQUIREMENTS FOR FABRICATION

#### 3.11.1 Drain Holes

When the collection of water inside a structural tube is a possibility, either during construction or during service, the tube shall be provided with a drain hole at its lowest point to let water out.

### 3.11.2 Welds

Special attention shall be given to developing sufficient weld throats on tubular members. Fillet weld details shall be in accordance with AWS D1.1, Section 3.9 (See AWS Figure 3.2). Unless determined otherwise by testing, the loss factor "Z" for heel welds shall be in accordance with AWS Table 2.8. Fillet welds which run onto the radius of a tube shall be built up to obtain the full throat thickness (See Figure 7.1). The maximum root openings of fillet welds shall not exceed 5 mm in conformance with AWS D1.1, Section 5.22. Weld size or effective throat dimensions shall be increased in accordance with this same section when applicable (i.e. fit-up gaps > 1.59 mm).

The fabricator shall have verified that the throat thickness of partial joint penetration groove welds (primarily matched edge welds or the flare-bevel-groove welds on underhung floor beams) shall be obtainable with their fit-up and weld procedures. Matched edge welds shall be "flushed" out when required to obtain the full throat or branch member wall thickness.

For full penetration butt welds of tubular members, the backing material shall be fabricated prior to installation in the tube so as to be continuous around the full tube perimeter, including corners. Backing may be of four types:

A "box" welded up from four (4) plates.

Two "channel" sections, bent to fit the inside radius of the tube, welded together with full penetration welds.

A smaller tube section which slides inside the spliced tube.

A solid plate cut to fit the inside radius of the tube.

Corners of the "box" backing, made from four plates, shall be welded and ground to match the inside corner radii of the chords. The solid plate option shall require a weep hole either in the chord wall above the "high side" of the plate or in the plate itself. In all types of backing, the minimum fit-up tolerances for backing must be maintained at the corners of the tubes as well as across the "flats".

### 3.12 QUALITY CERTIFICATION

Bridge(s) shall be fabricated by a fabricator who is currently certified by the American Institute of Steel Construction to have the personnel, organization, experience, capability, and commitment to produce fabricated structural steel for Simple Steel Bridge Structures as set forth in the AISC Certification Program. Quality control shall be in accordance with procedures outlined for AISC certification.

### 3.13 BLAST CLEANING

#### 3.13.1 Bare applications of enhanced corrosion resistant steels.

To aid in providing a uniformly "weathered" appearance, all exposed surfaces of steel shall be blast cleaned in accordance with Steel Structures Painting

Council Surface Preparation Specifications No. 7 Brush-Off Blast Cleaning, SSPC-SP7 latest edition.

Exposed surfaces of steel shall be defined as those surfaces seen from the deck and from outside of the structure. Stringers, floor beams, lower brace diagonals and the inside face of the truss below deck and bottom face of the bottom chord shall not be blasted.

### 3.14 DELIVERY AND ERECTION

Delivery is made to a location nearest the site which is easily accessible to normal over-the-road tractor/trailer equipment. All trucks delivering bridge materials will need to be unloaded at the time of arrival.

The manufacturer will provide detailed, written instruction in the proper lifting procedures and splicing procedures (if required). The method and sequence of erection shall be the responsibility of others.

The bridge manufacturer shall provide written inspection and maintenance procedures to be followed by the bridge owner.

### 3.15 BEARING DEVICES

Bridge bearings shall consist of a steel setting or slide plate placed on the abutment or grout pad. The bridge bearing plate which is welded to the bridge structure shall bear on this setting plate. One end of the bridge will be fixed by fully tightening the nuts on the anchor bolts at that end. The opposite end will have finger tight only nuts to allow movement under thermal expansion or contraction.

The bridge bearings shall sit in a recessed pocket on the concrete abutment. Minimum 28-day strength for the abutment concrete shall be xxxx PSI. The bearing seat shall be a minimum of 400 mm wide. The step height (from bottom of bearing to top-of-deck) shall be determined by the bridge manufacturer.

### 3.16 FOUNDATIONS

Engineering design, materials (including anchor bolts) and construction of the bridge supporting foundations (abutment, pier, bracket and/or footing) will be the responsibility of others. The contractor shall install the anchor bolts in accordance with the manufacturer's anchor bolt spacing dimensions.

Information as to bridge support reactions and anchor bolt locations will be furnished by the manufacturer after receipt of order and design is complete.

## SECTION 13121

## SPECIAL PURPOSE METAL BUILDING SYSTEMS

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## ALUMINUM ASSOCIATION (AA)

- |       |   |
|-------|---|
| AA-01 | (1993) Aluminum Standards and Data  |
| AA-02 | (1994) Aluminum Design Manual: Specification & Guidelines for Aluminum Structures |

## AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

- |                  |  |
|------------------|--|
| AISC-04          | (1989) Specification for Structural Steel Buildings - Allowable Stress Design, Plastic Design                            |
| AISC Pub No.S303 | (1992) Code of Standard Practice for Steel Buildings and Bridges   |
| AISC Pub No.S329 | (1985; Appx A Jun 1994) Allowable Stress Design Specification for Structural Joints Using ASTM A 325 or ASTM A 490 Bolts |

## AMERICAN IRON AND STEEL INSTITUTE (AISI)

- |         |  |
|---------|--|
| AISI-01 | (1996) Cold-Formed Steel Design Manual |
|---------|--|

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- |                   |  |
|-------------------|--|
| ASTM A 36/A 36M   | (1996) Carbon Structural Steel   |
| ASTM A 53         | (1996) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless                 |
| ASTM A 252        | (1993) Welded and Seamless Steel Pipe Piles  |
| ASTM A 325        | (1996) Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength         |
| ASTM A 463/A 463M | (1996a) Steel Sheet, Aluminum-Coated, by the Hot-Dip Process                               |
| ASTM A 490        | (1993) Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength               |
| ASTM A 500        | (1993) Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes |

ASTM A 501	(1993) Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
ASTM A 529/A 529M	(1994) High-Strength Carbon-Manganese Steel of Structural Quality
ASTM A 570/A 570M	(1996) Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality
ASTM A 572/A 572M	(1994c) High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A 588/A 588M	(1994) High-Strength Low-Alloy Structural Steel with 50 ksi (345 MPa) Minimum Yield Point to 4 in. (100 mm) Thick
ASTM A 606	(1996) Steel, Sheet and Strip, High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Atmospheric Corrosion Resistance
ASTM A 607	(1996) Steel, Sheet and Strip, High-Strength, Low-Alloy, Columbium or Vanadium, or Both, Hot-Rolled and Cold-Rolled
ASTM A 618	(1993; R 1995) Hot-Formed Welded and Seamless High-Strength Low-Alloy Structural Tubing
ASTM A 653/A 653M	(1996) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 792/A 792M	(1996) Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
ASTM B 117	(1995) Operating Salt Spray (Fog) Apparatus
ASTM B 209	(1996) Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B 221	(1996) Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B 241/B 241M	(1996) Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube
ASTM B 308/B 308M	(1996) Aluminum-Alloy 6061-T6 Standard Structural Profiles
ASTM B 429	(1995) Aluminum-Alloy Extruded Structural Pipe and Tube
ASTM D 522	(1993a) Mandrel Bend Test of Attached Organic Coatings
ASTM D 523	(1989; R 1994) Specular Gloss



ASTM D 714	(1987; R 1994) Evaluating Degree of Blistering of Paints
ASTM D 968	(1993) Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM D 1308	(1987; R 1993) Effect of Household Chemicals on Clear and Pigmented Organic Finishes
ASTM D 1654	(1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D 2244	(1993) Calculation of Color Differences from Instrumentally Measured Color Coordinates
ASTM D 2247	(1994) Testing Water Resistance of Coatings in 100% Relative Humidity
ASTM D 2794	(1993) Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
ASTM D 3359	(1995a) Measuring Adhesion by Tape Test
ASTM D 4214	(1989) Evaluating the Degree of Chalking of Exterior Paint Films
ASTM D 4587	(1991) Conducting Tests on Paint and Related Coatings and Materials Using a Fluorescent UV-Condensation Light-and Water-Exposure Apparatus

## AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7	(1995) Minimum Design Loads for Buildings and Other Structures
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## AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	(1996) Structural Welding Code - Steel
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## INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS (ICBO)

ICBO-01	(1994) Uniform Building Code
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## MATERIAL HANDLING INSTITUTE (MHI)

MHI CMAA 70	(1994) Electric Overhead Traveling Cranes
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## METAL BUILDING MANUFACTURERS ASSOCIATION (MBMA)

MBMA-01	(1996) Low Rise Building Systems Manual
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## UNDERWRITERS LABORATORIES (UL)

UL 580	(1994; Rev thru Sep 1997) Tests for Uplift Resistance of Roof Assemblies
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## 1.2 GENERAL

### 1.2.1 Building Configurations

Buildings shall have vertical walls and roofs as indicated. Roof slope shall be as indicated. Buildings shall be designed as clear span space frames using three-dimensional structural analysis without center columns or open knee bracing. Structures shall be pre-cut and prefabricated including: structural bolt-together frame, roof deck system, fasteners, trim, and installation instructions. Building dimensions shall be not less than those indicated, but exceeding the indicated dimensions only by the amount of the closest standard size thereto. Eave height shall be measured from the top of the finished floor to the intersection of the insides of the roof and sidewall sheets, or as shown. The clear opening between the finished floor and the bottom of the roof steel shall be as indicated.

### 1.2.2 Manufacturer

Pavillion shall be the product of a recognized metal building systems manufacturer who has been in the practice of manufacturing metal buildings of the size and complexity of the building shown on the contract drawings, for a period of no less than 5 years. The manufacturer shall be chiefly engaged in the practice of designing and fabricating metal building systems.

#### 1.2.2.1 Acceptable Manufacturers

Acceptable systems and manufacturers shall be one of the following:

1. 'OCT 28M' as manufactured by: W.H. Porter, Inc.  
Holland, MI  
616) 399-1963
2. Other equivalent manufacturers meeting the specifications herein.

### 1.2.3 Manufacturer's Representative

A representative of the metal building manufacturer, who is familiar with the design of the gazebo supplied and experienced in the erection of metal buildings similar in size to the one required under this contract, shall be present at the job site during construction from the start of the structural framing erection until completion of the installation of exterior covering to assure that the building meets the specified requirements.

### 1.2.4 Installer

Erector shall have specialized experience in the erection of metal building systems for a period of at least 5 years, and at least 2 years experience in the erection of metal buildings of the size and complexity shown and provided by the selected manufacturer.

### 1.3 DESIGN REQUIREMENTS

#### 1.3.1 Design Conditions

Loading combinations and definitions shall be in accordance with ASCE 7. Loading criteria as set out by MBMA-01 shall apply only where specifically stated by this specification.

##### 1.3.1.1 Dead Load

The dead load shall consist of the weight of the structural frame and all other materials of the gazebo.

##### 1.3.1.2 Collateral Loads

Collateral load of 24 kg/sq. meter Pa shall be applied to the entire structure to account for the weight of additional permanent materials other than the building system, such as sprinklers, mechanical systems, electrical systems, hung partitions, and ceilings. This allowance does not include the weight of hung equipment weighing 23 kilograms or more. Equipment loads of 222 N or more shall be investigated and the structure (frame, purlins, girts) shall be strengthened as required. The Contractor is responsible for providing the Building Manufacturer the magnitude and approximate location of all concentrated loads greater than 222 N.

##### 1.3.1.3 Roof Live Loads

Roof live loads shall be determined and applied in accordance with ASCE 7.

##### 1.3.1.4 Roof Snow Loads

The design roof snow loads shall be calculated in accordance with ASCE 7.

##### 1.3.1.5 Wind Loads

Wind pressures shall be computed and applied in accordance with ASCE 7 unless otherwise shown or directed by the Contracting Officer.

##### 1.3.1.6 Concentrated Loads

Concentrated loads shall be applied at locations indicated on the drawings.

##### 1.3.1.7 Seismic Loads

Seismic loads shall be computed for seismic zone 1 in accordance with ICBO-01 using an importance factor of 1.0.

##### 1.3.1.8 Impact Loads

Impact loads as required shall be applied as indicated in AISC-04.

#### 1.3.2 Framing and Structural Members

Structural steel members and their connections shall be designed in accordance with AISC-04. Structural cold-formed steel framing members and their connections shall be designed in accordance with AISI-01. Aluminum structural members and their connections shall be designed in accordance

with AA-02. Framed openings shall be designed to structurally replace the covering and framing displaced. The allowable live load deflection of roof elements shall not exceed  $1/240$ th of the span. Members with openings in their webs shall be designed with consideration of the additional stresses which will result due to the openings.

#### 1.3.3 Exterior Covering

Except as otherwise specified, steel covering shall be designed in accordance with AISI-01. Aluminum covering shall be designed in accordance with the AA-01. Section modulus and moment of inertia of aluminum sheet shall be determined for actual cross section dimensions by the conventional methods for actual design stresses and by effective width concept for deflection in accordance with AA-02. Maximum deflection for roof panels under full dead and live and/or wind loads shall not exceed  $1/240$ th of the span between supports. The design analysis shall establish that the roof when deflected under dead plus live or snow loads, will not result in a negative gradient. Maximum deflections shall be based on sheets continuous across two or more supports with sheets unfastened and fully free to deflect. In addition to the loads indicated above, the roof decking shall be designed for a 890 N concentrated load at midspan on a 300 mm wide section of deck. The methods for resisting lateral loads shall be cross-bracing, rigid frames, or wind columns.

#### 1.3.4 Drift Provision

Lateral deflections, or drift at the roof level of a structure in relation to the floor or slab on grade, caused by deflection of horizontal force resisting elements shall be calculated based on a 50-year mean recurrence interval and shall not exceed  $h/125$ .

### 1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

#### SD-01 Data

Design Analysis; GA.

Design analysis as one package with the detail drawings 40 days minimum prior to beginning of manufacture. The design analysis signed by a Registered Professional Engineer shall include a list of the design loads, and complete calculations for the building, its components, and the foundations. Formulas and references shall be identified. Assumptions and conclusions shall be explained, and cross-referencing shall be clear. The design analysis shall include, but not be limited to, the following wind and seismic information:

- a. Wind forces on various parts of the structure. Both positive and negative pressures shall be calculated with the controlling pressure summarized.
- b. Lateral forces due to seismic loading.

- c. Portions of the building for which design was controlled by seismic or wind forces shall be noted. A sketch identifying complete separation joints at the junctures between distinct parts of the building shall be provided.

Computer programmed designs shall be accompanied by stress values and a letter of certification, signed by a Registered Professional Engineer, stating the design criteria and procedures used and attesting to the adequacy and accuracy of the design. A narrative of the computer program delineating the basic methodology shall be included in the submittal. The program output shall be annotated and supplemented with sketches to make it easier for an engineer unfamiliar with the program to verify the input and output. Critical load conditions used in the final sizing of the members shall be emphasized. The design analysis shall include the name and office phone number of the designer and checker who function as a point of contact to answer questions during the detail-drawing review.

#### SD-04 Drawings

Metal Building Systems; GA.

Detail drawings consisting of catalog cuts, design and erection drawings containing an isometric view of the roof showing the design wind uplift pressure and dimensions of edge and corner zones; shop painting and finishing specifications, instruction manuals, manufacturer's recommended erection methods and procedures and other data as necessary to clearly describe design, material, sizes, layouts, construction details, fasteners, and erection. Manufacturer's recommended erection methods and procedures shall describe the basic sequence of assembly, temporary bracing, shoring, and related information necessary for erection of the metal building including its structural framework and components. A brief list of locations where buildings of similar design have been used shall be included with the detail drawings and shall include information regarding date of installation, name and address of owner, and how the structure is used.

#### SD-08 Statements

Qualifications; FIO.

Qualifications of the manufacturer, qualification of the manufacturer's representative who will provide job site assistance, and qualifications and experience of the building erector.

#### SD-13 Certificates

Metal Building Systems; FIO.

A Certificate from the metal building manufacturer stating that the metal building was designed from a complete set of the contract drawings and specifications and that the building furnished complies with the specified requirements.

Mill certification for structural bolts, framing steel, wall and roof covering, and wall liner panels.

## SD-14 Samples

## Accessories; FIO.

One sample of each type of flashing, trim, closure, cap and similar items. Size shall be sufficient to show construction and configuration.

## Roof Covering; GA.

One piece of each type and finish (exterior and interior) to be used, 230 mm long, full width. The sample for factory color finished covering shall be accompanied by certified laboratory test reports showing that the sheets to be furnished are produced under a continuing quality control program and that a representative sample consisting of not less than 5 pieces has been tested and has met the quality standards specified for factory color finish.

## Fasteners; FIO.

Two samples of each type to be used, with statement regarding intended use. If so requested, random samples of bolts, nuts, and washers as delivered to the jobsite shall be taken in the presence of the Contracting Officer and provided to the Contracting Officer for testing to establish compliance with specified requirements.

## Gaskets and Insulating Compounds; FIO.

Two samples of each type to be used and descriptive data.

## Sealant; FIO.

One sample, approximately 0.5 kg and descriptive data.

## 1.5 DELIVERY AND STORAGE

Materials shall be delivered to the site in a dry and undamaged condition and stored out of contact with the ground. Materials other than framing and structural members shall be covered with weathertight coverings and kept dry. Storage accommodations for roof and wall covering shall provide good air circulation and protection from surface staining.

## 1.6 GUARANTEE

The metal building system shall be guaranteed against water leaks arising out of or caused by ordinary wear and tear by the elements for a period of 5 years. Such guarantee shall start upon final acceptance of the work or the date the Government takes possession, whichever is earlier.

## 2 PRODUCTS

## 2.1 BUILDING COMPONENTS

Each piece or part of the assembly shall be clearly and legibly marked to correspond with the detail drawings.

## 2.2 FRAMING AND STRUCTURAL MEMBERS

Steel 3 mm or more in thickness shall conform to ASTM A 36/A 36M, ASTM A 529/A 529M, ASTM A 572/A 572M, or ASTM A 588/A 588M. Uncoated steel less than 3 mm in thickness shall conform to ASTM A 570/A 570M, ASTM A 606, or ASTM A 607. Galvanized steel shall conform to ASTM A 653/A 653M, G 90 coating designation, 1.143 mm minimum thickness. Aluminum-zinc coated steel shall conform to ASTM A 792/A 792M, AZ 55 coating designation, 1.143 mm minimum thickness. Aluminum sheet shall conform to ASTM B 209, 0.813 mm minimum thickness. Aluminum structural shapes and tubes shall conform to ASTM B 221, or ASTM B 308/B 308M. Structural pipe shall conform to ASTM A 53, ASTM A 252, ASTM A 500, ASTM A 501, ASTM A 618, ASTM B 221, ASTM B 241/B 241M or ASTM B 429. Holes for bolts shall be made in the shop.

## 2.3 ROOF COVERING

Panels shall be either steel or aluminum and shall have a factory color finish. Length of sheets shall be sufficient to cover the entire length of any unbroken roof slope or the entire height of any unbroken wall surface. Width of sheets with overlapping configurations shall provide not less than 610 mm of coverage in place, and those with interlocking ribs shall provide not less than 300 mm of coverage in place. Design provisions shall be made for thermal expansion and contraction consistent with the type of system to be used. Sheets shall be square cut, except gable end wall sheets may be cut in the shop to correspond to the roof slope and may have a horizontal joint at the eave line.

### 2.3.1 Roof Panels

Roof panels shall have configurations for overlapping sheets. Roof deck assemblies shall be Class 90 as defined in UL 580. System for securing the roof covering to structural framing members shall be exposed, penetrating fastener type. Height of corrugation at overlap of adjacent roof sheets shall be the building manufacturer's standard for the indicated roof slope.

### 2.3.2 Steel Covering

Zinc-coated steel conforming to ASTM A 653/A 653M, G 90 coating designation; aluminum-zinc alloy coated steel conforming to ASTM A 792/A 792M. AZ 55 coating; or aluminum-coated steel conforming to ASTM A 463/A 463M, Type 2, coating designation T2 65. Panels shall be 0.61 mm thick minimum, except that when the mid field of the roof is subject to design wind uplift pressures of 2.87 kPa or greater or the steel covering is used as a diaphragm the entire roof system shall have a minimum thickness of 0.762 mm. Prior to shipment, mill finish panels shall be treated with a passivating chemical and oiled to inhibit the formation of oxide corrosion products. Panels that have become wet during shipment but have not started to oxidize shall be dried, retreated, and re-oiled.

### 2.3.3 Aluminum Covering

Alloy conforming to ASTM B 209, temper as required for the forming operation, minimum 0.813 mm thick.

#### 2.3.4 FACTORY COLOR FINISH

Panels shall have a factory applied polyvinylidene fluoride finish on the exposed side. The exterior finish shall consist of a baked-on topcoat with an appropriate prime coat. Color shall match the color indicated in Section 09915 COLOR SCHEDULE. The exterior coating shall be a nominal 0.025 mm thickness consisting of a topcoat of not less than 0.018 mm dry film thickness and the paint manufacturer's recommended primer of not less than 0.008 mm thickness. The interior color finish shall consist of the same coating and dry film thickness as the exterior. The exterior color finish shall meet the test requirements specified below.

##### 2.3.4.1 Salt Spray Test

A sample of the sheets shall withstand a salt spray test for a minimum of 1000 hours in accordance with ASTM B 117, including the scribe requirement in the test. Immediately upon removal of the panel from the test, the coating shall receive a rating of not less than 8F, few No. 8 blisters, as determined by ASTM D 714; and a rating of 6, 3 mm failure at scribe, as determined by ASTM D 1654.

##### 2.3.4.2 Formability Test

When subjected to testing in accordance with ASTM D 522 Method B, 3 mm diameter mandrel, the coating film shall show no evidence of cracking to the naked eye.

##### 2.3.4.3 Accelerated Weathering, Chalking Resistance and Color Change

A sample of the sheets shall be tested in accordance with ASTM D 4587, test condition D for 1000 total hours. The coating shall withstand the weathering test without cracking, peeling, blistering, loss of adhesion of the protective coating, or corrosion of the base metal. Protective coating that can be readily removed from the base metal with tape in accordance with ASTM D 3359, Test Method B, shall be considered as an area indicating loss of adhesion. Following the accelerated weathering test, the coating shall have a chalk rating not less than No. 8 in accordance with ASTM D 4214 test procedures, and the color change shall not exceed 5 CIE or Hunter Lab color difference (delta E) units in accordance with ASTM D 2244. For sheets required to have a low gloss finish, the chalk rating shall be not less than No. 6 and the color difference shall be not greater than 7 units.

##### 2.3.4.4 Humidity Test

When subjected to a humidity cabinet test in accordance with ASTM D 2247 for 1000 hours, a scored panel shall show no signs of blistering, cracking, creepage or corrosion.

##### 2.3.4.5 Impact Resistance

Factory-painted sheet shall withstand direct and reverse impact in accordance with ASTM D 2794 13 mm diameter hemispherical head indenter, equal to 6.7 times the metal thickness in mm, expressed in Newton-meters, with no loss of adhesion.



#### 2.3.4.6 Abrasion Resistance Test

When subjected to the falling sand test in accordance with ASTM D 968, Method A, the coating system shall withstand a minimum of 80 liters of sand before the appearance of the base metal. The term "appearance of base metal" refers to the metallic coating on steel or the aluminum base metal.

#### 2.3.4.7 Specular Gloss

Finished roof surfaces for shall have a specular gloss value of 30 plus or minus 5 at 33.33 degrees C when measured in accordance with ASTM D 523.

#### 2.3.4.8 Pollution Resistance

Coating shall show no visual effects when covered spot tested in a 10 percent hydrochloric acid solution for 24 hours in accordance with ASTM D 1308.

#### 2.3.5 Accessories

Flashing, trim, metal closure strips and curbs, fascia, caps, diverters, and similar metal accessories shall be not less than the minimum thickness specified for covering. Accessories shall be compatible with the system furnished. Exposed metal accessories shall be finished to match the covering building finish. Molded closure strips shall be bituminous-saturated fiber, closed-cell or solid-cell synthetic rubber or neoprene, or polyvinyl chloride premolded to match configuration of the covering and shall not absorb or retain water.

### 2.4 FASTENERS

Fasteners for steel wall and roof panels shall be zinc-coated steel, aluminum, corrosion resisting steel, or nylon capped steel, type and size specified below or as otherwise approved for the applicable requirements. Fasteners for aluminum wall and roof panels shall be aluminum or corrosion resisting steel. Fasteners for structural connections shall provide both tensile and shear strength of not less than 3.34 kN per fastener. Fasteners for accessories shall be the manufacturer's standard. Exposed roof fasteners shall be gasketed or have gasketed washers on the exterior side of the covering to waterproof the fastener penetration. Washer material shall be compatible with the covering; have a minimum diameter of 10 mm for structural connections; and gasketed portion of fasteners or washers shall be neoprene or other equally durable elastomeric material approximately 3 mm. When wall covering is factory color finished, exposed wall fasteners shall be color finished or provided with plastic color caps to match the covering. Nonpenetrating fastener system using concealed clips shall be manufacturer's standard for the system provided.

#### 2.4.1 Screws

Screws shall be as recommended by the manufacturer to meet the strength design requirements of the panels.

#### 2.4.2 End-Welded Studs

Automatic end-welded studs shall be shouldered type with a shank diameter of not less than 4.5 mm and cap or nut for holding covering against the shoulder.

#### 2.4.3 Explosive Actuated Fasteners

Fasteners for use with explosive actuated tools shall have a shank diameter of not less than 3.68 mm with a shank length of not less than 13 mm for fastening panels to steel and not less than 25 mm for fastening panels to concrete.

#### 2.4.4 Blind Rivets

Blind rivets shall be aluminum with 5 mm nominal diameter shank or stainless steel with 3 mm nominal diameter shank. Rivets shall be threaded stem type if used for other than the fastening of trim. Rivets with hollow stems shall have closed ends.

#### 2.4.5 Bolts

Bolts shall be not less than 6 mm diameter, shouldered or plain shank as required, with proper nuts.

#### 2.5 SEALANT

Sealant shall be an elastomeric type containing no oil or asphalt. Exposed sealant shall be colored to match the applicable building color and shall cure to a rubberlike consistency. Concealed sealant may be the nonhardening type.

#### 2.6 GASKETS AND INSULATING COMPOUNDS

Gaskets and insulating compounds shall be nonabsorptive and suitable for insulating contact points of incompatible materials. Insulating compounds shall be nonrunning after drying.

#### 2.7 SHOP PRIMING

Ferrous surfaces shall be cleaned of oil, grease, loose rust, loose mill scale, and other foreign substances and shop primed. Primer coating shall be in accordance with the manufacturer's standard system.

### 3 EXECUTION

#### 3.1 ERECTION

##### 3.1.1 General

Erection shall be in accordance with the approved erection instructions and drawings and with applicable provision of AISC-04. The completed buildings shall be free of excessive noise from wind-induced vibrations under the ordinary weather conditions to be encountered at the location where the building is erected, and meet all specified design requirements. Dissimilar materials which are not compatible when contacting each other shall be insulated from each other by means of gaskets or insulating compounds.

Framing members fabricated or modified on site shall be saw or abrasive cut; bolt holes shall be drilled. Onsite flame cutting of framing members, with the exception of small access holes in structural beam or column webs, shall not be permitted. Improper or mislocated drill holes shall be plugged with an oversize screw fastener and gasketed washer; however, sheets with an excess of such holes or with such holes in critical locations shall not be used. Improper or mislocated bolt holes in structural members or other misfits caused by improper fabrication or erection, shall be repaired in accordance with AISC Pub No.S303. Exposed surfaces shall be kept clean and free from sealant, metal cuttings, excess material from thermal cutting, and other foreign materials. Exposed surfaces which have been thermally cut shall be finished smooth within a tolerance of 3 mm inch. Stained, discolored or damaged sheets shall be removed from the site. Welding of steel shall conform to AWS D1.1; welding of aluminum shall conform to AA-02. High-strength bolting shall conform to AISC Pub No.S329 using ASTM A 325 or ASTM A 490 bolts. Concrete work is specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE.

### 3.1.2 Framing and Structural Members

Anchor bolts shall be accurately set by template while the concrete is in a plastic state. Uniform bearing under base plates and sill members shall be provided using a nonshrinking grout when necessary. Members shall be accurately spaced to assure proper fitting of covering. Separate leveling plates under column base plates shall not be used. As erection progresses, the work shall be securely fastened to resist the dead load and wind and erection stresses. Supports for electric overhead traveling cranes shall be positioned and aligned in accordance with MHI CMAA 70.

### 3.1.3 Roof Covering

Wall covering shall be applied with the longitudinal configurations in the vertical position. Roof covering shall be applied with the longitudinal configurations in the direction of the roof slope. Accessories shall be fastened into framing members, except as otherwise approved. Closure strips shall be provided as indicated and where necessary to provide weathertight construction.

#### 3.1.3.1 Lap Type Panels with Exposed Fasteners

Except for self-framing buildings, end laps shall be made over framing members with fasteners into framing members approximately 50 mm from the end of the overlapping sheet. Side laps shall be laid away from the prevailing winds. Side lap distances, end lap distances, joint sealing, and spacing and fastening of fasteners shall be in accordance with the manufacturer's standard practice insofar as the maximum spacings specified are not exceeded and provided such standard practice will result in a structure which will be free from water leaks and meet design requirements. Spacing of fasteners shall present an orderly appearance and shall not exceed: 200 mm on center at end laps of covering, 300 mm on center at connection of covering to intermediate supports, 300 mm on center at side laps of roof coverings, and 450 mm on center at side laps of wall coverings except when otherwise approved. Side laps and end laps of roof and wall covering and joints at accessories shall be sealed. Fasteners shall be installed in straight lines within a tolerance of 13 mm in the length of a bay. Fasteners shall be driven normal to the surface and to a uniform depth to properly seat the gasketed washers.

### 3.1.3.2 Concealed Fastener Wall Panels

Panels shall be fastened to framing members with concealed fastening clips or other concealed devices standard with the manufacturer. Spacing of fastening clips and fasteners shall be in accordance with the manufacturer's written instructions insofar as the maximum fastener spacings specified are not exceeded and provided such standard practice will result in a structure which will be free from water leaks and meet design requirements. Spacing of fasteners and anchor clips along the panel interlocking ribs shall not exceed 300 mm on center except when otherwise approved. Fasteners shall not puncture covering sheets except as approved for flashing, closures, and trim; exposed fasteners shall be installed in straight lines. Interlocking ribs shall be sealed according to manufacturer's recommendations. Joints at accessories shall be sealed.

### 3.2 FIELD PAINTING

Immediately upon detection, abraded or corroded spots on shop-painted surfaces shall be wire brushed and touched up with the same material used for the shop coat. Shop-primed ferrous surfaces exposed on the outside of the building and all shop-primed surfaces of doors and windows shall be painted with two coats of an approved exterior enamel. Factory color finished surfaces shall be touched up as necessary with the manufacturer's recommended touch-up paint.

## SECTION 13814

## BUILDING PREPARATION FOR ENERGY MONITORING AND CONTROL SYSTEMS (EMCS)

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME-18 (1971; Int. Supple 19.5-1972; Errata 1974)  
Fluid Meters, Their Theory and Application

## INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C57.13 (1993) Instrument Transformers

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (1991) Enclosures for Electrical Equipment  
(1000 Volts Maximum)

NEMA ICS 1 (1993) Industrial Controls and Systems

## 1.2 GENERAL REQUIREMENTS

## 1.2.1 Preparation of Building for Interface

The Contractor shall provide all services, materials, and equipment necessary to prepare the building for interface to the existing Post-wide EMCS. The existing system was provided and installed by Williams Electric Company (WEC) of Ft. Walton Beach, Florida.

## 1.2.2 Environmental Conditions

All equipment shall be rated for continuous operation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified or normally encountered at the installed location.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Equipment and Performance; GA.

Six copies of the hardware and maintenance data, in manual format, bound in hardback, loose-leaf binders, within 30 days after completing the site testing. The contents of each manual shall be identified on the cover. The

manuals shall include the names, addresses, and telephone numbers of each subcontractor installing equipment and systems, and of the nearest service representatives for each item of equipment and each system. The manuals shall have a table of contents and tab sheets. Tab sheets shall be placed at the beginning of each chapter or section and at the beginning of each appendix. The final copies, to be submitted after completion of the site test, shall include all modifications made during installation, checkout, and acceptance.

Hardware data, shall describe all equipment provided, including:

- a. General description and specifications.
- b. Installation and checkout procedures.
- c. Electrical schematics and layout drawings.
- d. Alignment and calibration procedures.
- e. Manufacturer's repair parts list indicating sources of supply, and National Stock Number when obtainable from the manufacturer.
- f. Interface definition.

The maintenance data, shall include descriptions of maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

#### SD-04 Drawings

Equipment and Material; GA.

Detail drawings consisting of a complete list of equipment and material, including manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts, and installation instructions. Drawings shall contain complete wiring, routing, and schematic diagrams. Drawings shall show proposed layout and installation of all equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

#### SD-08 Statements

Test Plan; GA.

Five copies of test plan and test procedure. Five copies of test report that documents the test results, in booklet form. Test plan documents for the test, 120 days prior to the test. The test plan shall define all the tests required to ensure that the equipment meets technical and performance specifications. The test plan shall define milestones for the test exercises and shall identify the capabilities and functions to be tested.

Test Procedure; GA.

Test procedure documents, 60 days prior to the test. Test procedures shall be developed from the test plans and design documentation. The procedures shall consist of detailed instructions for test setup, execution, and evaluation of test results. The procedures shall explain and shall detail,

step by step, actions and expected results to demonstrate the requirements of this specification and the methods for simulating the necessary conditions of operation to demonstrate performance of the equipment. All test equipment to be used shall be furnished by the Contractor.

#### SD-09 Reports

Site Testing; GA.

Test report, within 15 days after completion of the test. The test report shall be used to document results of the test.

## 2 PRODUCTS

### 2.1 STANDARD PRODUCTS

Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of such products. Units of the same type of equipment shall be products of a single manufacturer.

### 2.2 ENCLOSURES

Enclosures shall conform to the requirements of NEMA 250 for the types specified. Finish color shall be the manufacturer's standard, unless otherwise indicated. Damaged surfaces shall be repaired and refinished using original type finish. Enclosures installed indoors shall be Type 12, or as shown. Equipment installed outdoors shall be housed in a Type 4 enclosure, unless otherwise shown.

### 2.3 NAMEPLATES

Laminated plastic nameplates shall be provided for all equipment furnished. Each nameplate shall identify the function, such as "mixed air controller" or "cold deck temperature sensor." Laminated plastic shall be 3 mm thick, white with black center core. Nameplates shall be a minimum of 25 by 75 mm, with minimum 6 mm high engraved block lettering. Nameplates for devices smaller than 25 by 75 mm shall be attached by a nonferrous metal chain. All other nameplates shall be attached to the equipment.

### 2.4 INSTRUMENTATION AND CONTROL (I&C) DIAGRAMS

Framed mylar drawings in laminated plastic shall be provided. Drawings shall show complete I&C diagrams for all equipment furnished and interfaces to all existing equipment, at each respective equipment location. Condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system manually shall be prepared in typed form, framed as specified for the I&C diagrams and posted beside the diagrams. Proposed diagrams, instructions, and other sheets shall be submitted prior to posting. The instructions shall be posted after completion of the Contractor's site testing. Provide a mylar reproducible of each I&C diagram in addition to the posted copy.

### 2.5 DATA TERMINAL CABINET (DTC)

Data terminal cabinet shall be provided for each mechanical room as an interface to the data environment (DE) instrumentation and controls. No

instrumentation and control devices shall be located within the DTC. DTCs shall be required if the SLDC HVAC controls option is selected by the Contractor. DTCs shall be the interface point for connection of all EMCS points to the EMCS Field Interface Devices (FID) If the Williams Electric Company Direct Digital Controls (DDC) options is selected by the contractor, DTCs are not required but all EMCS points shall be wired from HVAC panels and/or field locations to the WEC HVAC control panels for connection to the EMCS.

#### 2.5.1 Enclosure

The DTC shall be a separate metallic enclosure. The DTC shall be sized to accommodate the number of functions required by the control and monitoring devices as shown plus 25 percent expansion for each type of function provided.

#### 2.5.2 Groupings

The DTC shall be divided into analog and digital groupings, each with separate sensor and control signal wiring raceways.

#### 2.5.3 Terminal Strips

The DTC shall be provided with double sided screw type terminal strips. One side of the terminal strip shall be used for termination of field wiring from instrumentation and controls. The other side shall be used to connect the DTC to the FID or MUX. Terminal strips shall have individual terminal identification numbers.

#### 2.5.4 Power

A 120-Vac, 15-A, 60 Hz duplex outlet shall be provided within 1.8 m of each DTC.

### 2.6 INSTRUMENTATION AND CONTROL

#### 2.6.1 Temperature Instruments

##### 2.6.1.1 Resistor Temperature Detector (RTD)

RTDs shall be platinum with an accuracy of plus or minus 0.1 percent at 0.0 degrees C (32 degrees F) and shall be encapsulated in epoxy, series 300 stainless steel, anodized aluminum, or copper. Each RTD shall be furnished with an RTD transmitter specified and mounted integrally, unless otherwise shown.

##### 2.6.1.2 Resistor Temperature Detector (RTD) Transmitters

The RTD transmitter shall be selected to match the resistance range of the platinum RTD. The transmitter shall produce a linear 4 to 20 mAdc output corresponding to the required temperature span. The output error shall not exceed 0.1 percent of calibrated span. The transmitter shall include offset and span adjustments unless the RTD element is integral to the transmitter and system calibration is provided.



#### 2.6.1.3 Continuous Averaging RTDs

Continuous averaging RTDs shall have an accuracy of plus or minus 0.6 degree C at the reference temperature, and shall be of sufficient length to ensure that the resistance represents an average over the cross section in which it is installed. The sensor shall have a bendable copper sheath. Each averaging RTD shall be furnished with an RTD transmitter selected to match the resistance range of the averaging RTD. The transmitter shall produce a linear 4 to 20 mA<sub>dc</sub> output corresponding to the required temperature span. The output error of the transmitter shall not exceed 0.1 percent of the calibrated span. The transmitter shall include offset and span adjustments.

#### 2.6.1.4 Thermowells

Thermowells shall be monel, brass, or copper for use in copper water lines, wrought iron for measuring flue gases, and series 300 stainless steel for all other applications. The thermowell shall include a connection box, sized to accommodate the temperature transmitter.

### 2.6.2 Pressure Instruments

#### 2.6.2.1 Pressure Transducers

Pressure transducers shall withstand up to 150 percent of rated pressure, with an accuracy of plus or minus 1 percent of full scale. The sensing element shall be either capsule, diaphragm, bellows, bourdon tube, or solid state. A transmitter located at the transducer shall be provided to convert the sensing element output to a linear 4 to 20 mA<sub>dc</sub> output corresponding to the required pressure span. The output error shall not exceed 0.1 percent of calibrated span. The transmitter shall include offset and span adjustments.

#### 2.6.2.2 Pressure Switches

Pressure switches shall have a repetitive accuracy of plus or minus 5 percent of their operating range and shall withstand up to 150 percent of rated pressure. Sensors shall be diaphragm or bourdon tube. Switch actuation shall be adjustable over the operating pressure range. Switch shall have a snap-action Form C contact rated for the application. Gauge pressure switches shall have an adjustable differential setting.

### 2.6.3 Flow Instruments

#### 2.6.3.1 Orifice Plates

Orifice plates shall be made of a series 300 stainless steel sheet of 3.2 mm (0.125 inch) nominal thickness with an accuracy of plus or minus 1 percent of full flow. The orifice plate shall be flat within 25.4 micrometers. The orifice surface roughness shall not exceed 0.5 micrometers. The thickness of the cylindrical face of the orifice shall not exceed 1/50 of the pipe inside diameter or 1/8 of the orifice diameter, whichever is smaller. The upstream edge of the orifice shall be square and sharp.

#### 2.6.3.2 Flow Nozzles

Flow nozzles shall be made of series 300 stainless steel with an accuracy of plus or minus 1 percent of full flow. The inlet nozzle form shall be

elliptical and the nozzle throat shall be the quadrant of an ellipse. The thickness of the nozzle wall and flange shall be such that distortion of the nozzle throat from strains caused by the pipeline temperature and pressure, flange bolting, or other methods of installing the nozzle in the pipeline shall not cause the accuracy to degrade beyond the specified limit. The outside diameter of the nozzle flange or the design of the flange facing shall be such that the nozzle throat shall be centered accurately in the pipe.

#### 2.6.3.3 Venturi Tubes

Venturi tubes shall be made of cast-iron or cast-steel and shall have an accuracy of plus or minus 1 percent of full flow. The throat section shall be lined with series 300 stainless steel. Thermal expansion characteristics of the lining shall be the same as that of the throat casting material. The surface of the throat lining shall be machined to a 1.3 micrometers finish, including the short curvature leading from the converging entrance section into the throat.

#### 2.6.3.4 Annular Pitot Tubes

Annular pitot tubes shall be averaging type differential pressure sensors with four total head pressure ports and one static port made of series 300 stainless steel. Sensor shall have an accuracy of plus or minus 2 percent of full flow.

#### 2.6.3.5 Turbine Meters

Turbine meters shall be series 300 stainless steel with an accuracy of plus or minus 1 percent from 30 to 100 percent of actual flow. Turbine flowmeters shall consist of two components, a turbine and an electronic transmitter. The turbine shall measure the flow, and the electronic transmitter shall produce a linear analog output of 4 to 20 mAdc corresponding to the required flow span. The transmitter shall include offset and span adjustments.

#### 2.6.3.6 Vortex Shedding Flowmeters

The vortex flowmeter shall produce an analog 4 to 20 mAdc signal that is linearly proportional to the volumetric flow rate. The accuracy shall be within plus or minus 0.8 percent of the actual flow. The electronic transmitter for the vortex flowmeter shall allow either internal or external mounting, within 15 m (50 feet) of the flow sensor. The flowmeter body shall be made of series 300 stainless steel.

#### 2.6.3.7 Flow Switches

Flow switches shall have a repetitive accuracy of plus or minus 1 percent of its operating range. Switch actuation shall be adjustable over the operating flow range. The switch shall have a snap-action Form C contact rated for the application.

### 2.6.4 Electric Power Instruments

#### 2.6.4.1 Potential Transformers

Potential transformers shall conform to IEEE C57.13.

#### 2.6.4.2 Current Transformers

Current transformers shall conform to IEEE C57.13.

#### 2.6.4.3 Watthour Meters

Watthour meters and meter sockets shall conform to ANSI C12.1. Meters shall have pulse initiators for remote monitoring of watthour consumption. Pulse initiator shall consist of Form C contacts with a current rating not to exceed 2 amperes and voltage not to exceed 500 volts, with combinations of VA not to exceed 100 VA, and a life rating of one billion operations.

#### 2.6.4.4 Transducers

Transducers in kjoule shall have an accuracy of plus or minus 0.25 percent for outputs from full lag to full lead power factor. Input ranges for transducers shall be selectable without requiring the changing of current or potential transformers. The output shall be 4 to 20 mAdc.

#### 2.6.4.5 Current Sensing Relays

Current sensing relays shall be of a design that provides a normally-open (NO) single-pole, single-throw (SPST) contact rated at a minimum of 50 volts peak and one-half ampere or 25 VA, noninductive. Current sensing relays shall be single unit construction with provisions for firm mounting. They have a single hole for passage of current carrying conductors and sized for operation at a nominal 50 percent of current rating of sensed device. The Contractor shall use multiple turns of sensed leads for higher rate loads. Voltage isolation shall be for a minimum of 600 volts.

#### 2.6.5 Output Devices

##### 2.6.5.1 Control Relays

Control relay contacts shall be rated for the application, with a minimum of 2 sets of Form C contacts enclosed in a dust-proof enclosure. Relays shall be rated for a minimum life of one million mechanical operations. Operating time shall be 20 milliseconds or less, with release time of 10 milliseconds or less. Relays shall be equipped with coil transient suppression devices to limit transients to 150 percent of rated coil voltage.

##### 2.6.5.2 Time Delay Relays

Time delay relay contacts shall be rated for the application with a minimum of 2 sets of Form C contacts enclosed in a dust-proof enclosure. Relays shall be rated for a minimum life of one million mechanical operations. Relays shall be equipped with coil transient suppression devices to limit transients to 150 percent of rated coil voltage. Delayed contact opening or closing shall be adjustable from 1 to 60 seconds with a minimum accuracy of plus or minus 2 percent of setting.

##### 2.6.5.3 Latching Relays

Latching relay contacts shall be rated for the application with a minimum of 2 sets of Form C contacts enclosed in a dust-proof enclosure. Relays shall be rated for a minimum life of one million mechanical operations. Operating

time shall be 20 milliseconds or less, with release time of 10 milliseconds or less. Relays shall be equipped with coil transient suppression devices to limit transients to 150 percent of rated coil voltage.

#### 2.6.5.4 Reed Relays

Reed relays shall be encapsulated in a container housed in a plastic, epoxy, or metal case. Contacts shall be rated for the application. Operating and release times shall be 1 millisecond or less. Relays shall be rated for a minimum life of 10 million mechanical operations and shall be equipped with coil transient suppression devices to limit transients to 150 percent of rated coil voltage.

#### 2.6.5.5 Contactors

Contactors shall be of the single coil, electrically operated, mechanically held type. Positive locking shall be obtained without the use of hooks, latches, or semipermanent magnets. Contacts shall be double-break silver-to-silver type protected by arcing contacts where necessary. Number of contacts and ratings shall be selected for the application. Operating and release times shall be 100 milliseconds or less. Contactors shall be equipped with coil transient suppression devices to limit transients to 150 percent of rated coil voltage.

#### 2.6.5.6 Solid State Relays

Input-output isolation shall be greater than 1000 megohms with a breakdown voltage of 1500 volts root mean square or greater at 60 Hz. Relays shall be rated for a minimum life of 10 million operations. The ambient temperature range shall be at least minus 28.9 degrees C to plus 60.0 degrees C. Input impedance shall not be less than 500 ohms. Relays shall be rated for the application. Operating and release times shall be 1 millisecond or less. Transients shall be limited to 150 percent of control voltage. Solid state relays shall not be used on inductive loads which are switched on-off.

#### 2.6.5.7 Electric Solenoid Operated Pneumatic (EP) Valve

EP valves shall have three port operations: common, normally open, and normally closed. EP valves shall have an outer cast aluminum body with internal parts constructed of brass, bronze, or stainless steel. The air connection shall be a 10 mm NPT threaded connection. EP valves shall be rated for 344 kPa when used in control system operation at 172 kPa or less, or rated at 1 MPa when used in control system operation from 172 to 690 kPa. EP coils shall be equipped with transient suppression to limit transients to 150 percent of rated voltage. EP valve operation shall be rated for a minimum of 104 degrees C.

#### 2.6.5.8 Electric to Pneumatic (EP) Transducers

EP transducers shall be matched to a signal of 4 to 20 mAdc and have linearly proportional pneumatic output compatible with the pneumatic control loop to be interfaced. The EP transducer shall have pressure calibration adjustments and shall withstand pressures at least 150 percent of the maximum range. The pneumatic output shall be linearly proportional within 1 percent of the electric input. Transducers shall have offset and span adjustment capabilities. EP transducers shall be rated for zero to minus 17.8 degrees C to plus 60.0 degrees C continuous operation. The body shall

be cast aluminum with internal parts constructed of brass, bronze, or stainless steel.

#### 2.6.5.9 Motorized Potentiometers

Motorized potentiometers shall be reversible brushless alnico or samarium cobalt permanent magnet dc motors with rotary potentiometers coupled to the motor or gearhead output shaft. Motors shall be 22 mm diameter or larger, with a minimum rated life of 1,000 operating hours or 200,000 revolutions. Motors shall accept signals for clockwise rotation and counterclockwise rotation. With no signal present, the motor shall remain stationary. Rotary potentiometers shall be wirewound or conductive plastic, single or multiturn potentiometers with a minimum rated life of 200,000 revolutions. Potentiometers shall have a maximum resistance tolerance of plus or minus 10 percent and a maximum linearity tolerance of plus or minus 1 percent. Potentiometers shall be rated for a minimum of 1 watt at 52 degrees C. Motorized potentiometers shall be housed in enclosures meeting both NEMA Type 4 and NEMA Type 13 ratings, and shall be suitable for operation at ambient temperatures of 1.7 degrees C to 48.9 degrees C.

#### 2.6.5.10 Potentiometer to Current Transducers

Potentiometer to current transducers shall have an accuracy of plus or minus 0.1 percent of span for 3-wire potentiometer inputs between 100 and 10,000 ohms full scale. Potentiometer transducers shall provide continuous span adjustments between 75 and 100 percent of the input range and continuous zero offset adjustment between 0 and 10 percent of the input range. Potentiometer transducers shall provide excitation current to the potentiometer and shall drive a 4 to 20 mA dc output signal, with 500 volts peak to peak isolation between input and output terminals. Potentiometer transducers shall be suitable for operation at ambient temperatures of minus 28.9 degrees C to plus 79.4 degrees C.

#### 2.6.6 Position Sensors

##### 2.6.6.1 End (Limit) Switches

Limit switches shall be of the sealed or enclosed type as required for the application. Contacts shall be snap-action Form C rated for the application.

##### 2.6.6.2 Potentiometers

Potentiometers may be either rotary or linear, depending on the application of each position indicator. Position potentiometers shall have a linearity of plus or minus 5 percent and shall indicate position on a percent open basis.

#### 2.6.7 Key Operated Switches

Hand-off-automatic (HOA), off-automatic, and all similar-use switches shall be key operated with all switches keyed alike. All switches shall be rated for a minimum of 600 Vac, 5-A, and shall be mounted in an enclosure as specified or shown. An auxiliary set of contacts rated for at least 120 Vac, 1 ampere shall be provided with each switch.

## 2.7 WIRE AND CABLE

The Contractor shall provide all wire and cable from the sensors and control devices in the DE to the DTCs.

### 2.7.1 Control Wiring

#### 2.7.1.1 Digital Functions

Control wiring for digital functions shall be No. 18 AWG minimum with 600-volt insulation. Multiconductor wire shall have an outer jacket of Polyvinyl Chloride (PVC).

#### 2.7.1.2 Analog Functions

Control wiring for analog functions shall be No. 18 AWG minimum with 600-volt insulation, twisted and shielded, 2-, 3-, or 4-wire to match analog function hardware. Multiconductor wire shall have an outer jacket of PVC.

### 2.7.2 Sensor Wiring

Sensor wiring shall be No. 20 AWG minimum twisted and shielded, 2-, 3-, 4-wire to match analog function hardware. Multiconductor wire shall have an outer jacket of PVC.

### 2.7.3 Class 2 Low Energy Conductors

The conductor types and sizes specified for digital and analog functions shall take precedence over any requirements for Class 2 low energy remote control and signal circuit conductors specified elsewhere.

## 2.8 RACEWAY SYSTEMS

Raceway systems from the sensors and control devices in the DE to the DTCs shall be provided by the Contractor.

## 3 EXECUTION

### 3.1 GENERAL INSTALLATION REQUIREMENTS

The Contractor shall install all components and appurtenances in accordance with the manufacturer's instructions and as shown or specified. All necessary interconnections, services, and adjustments required to prepare the building for interface to an EMCS shall be furnished. All wiring, including low voltage wiring, shall be installed in metallic raceways. All other electrical work shall be in accordance with Section 16415 and as shown. Instrumentation grounding as necessary to preclude ground loops and noise from adversely affecting equipment operations shall be installed.

### 3.2 I/O SUMMARY TABLES

I/O Summary Tables shall be used in conjunction with the drawings to identify the hardware required for each building and system.

### 3.3 EQUIPMENT INSTALLATION

#### 3.3.1 Temperature Instruments

##### 3.3.1.1 Resistor Temperature Detector (RTD)

When the RTD is installed in pipes or is susceptible to corrosion and vibration, the RTD shall be installed in a thermowell. RTDs which are attached to surfaces shall be clamped or bonded in place. The surface shall be thoroughly cleaned, degreased, and after RTD installation, shall be insulated from ambient temperature effects. RTDs used for space temperature sensing shall include a housing suitable for wall mounting. RTDs used for OA sensing shall have an instrument shelter to minimize solar effects, and shall be mounted to minimize building effects. RTD assemblies shall be readily accessible and installed in a manner as to allow easy replacement.

##### 3.3.1.2 Temperature Switches

Temperature switches shall be installed as specified for RTDs. Temperature switches shall be adjusted to the proper setpoint and shall be verified by calibration. Switch contact ratings and duty shall be selected in accordance with NEMA ICS 1.

#### 3.3.2 Relative Humidity Sensors

Relative humidity sensors shall have air guards when installed in air flows of more than 50 feet per minute across the sensor element.

#### 3.3.3 Pressure Instruments

##### 3.3.3.1 Pressure Sensors

Pressure sensors (all types) installed on liquid lines shall have drains. Pressure sensors installed on steam lines shall have drains and siphons. All pressure sensors shall have valves for isolation, venting, and taps for calibration. Pressure sensors shall be verified by calibration. Differential pressure sensors shall have nulling valves.

##### 3.3.3.2 Pressure Switches

Pressure switches (all types) installed on liquid lines shall have drains. Pressure sensors installed on steam lines shall have drains and siphons. All pressure switches in water and steam lines shall have valves for isolation, venting, and taps for calibration. Pressure switches shall be adjusted to the proper setpoint, and shall be verified by calibration. Pressure switches shall be mounted higher than the process connection. Differential pressure switches shall have nulling valves. Switch contact ratings and duty shall be selected in accordance with NEMA ICS 1.

#### 3.3.4 Flow Instruments

##### 3.3.4.1 Flowmeters

Flowmeters shall be installed in accordance with ASME-18.

#### 3.3.4.2 Orifice Plates

Orifice plates shall be located in horizontal pipe runs. For liquid measurement, the orifice plate flanges shall be installed so that the pressure taps are in the horizontal plane with the centerline of the pipe. For gas measurement, the orifice plate flanges shall be installed so that the pressure taps are 45 degrees or more above the horizontal plane with the centerline of the pipe. For steam measurement, eccentric orifice plate flanges shall be installed so that the pressure taps are 45 degrees below, or in the horizontal plane with the centerline of the pipe. Orifice plates shall be installed for ease of accessibility for periodic maintenance. The differential pressure sensors shall be as close to the orifice plates as possible. For gas measurement the required differential pressure transmitter shall be physically installed above the orifice taps. For steam, the required differential pressure transmitter shall be physically installed a minimum of 200 mm below the taps. For liquid, the differential pressure transmitter shall be installed below the orifice tops.

#### 3.3.4.3 Flow Nozzles

Flow nozzles shall be installed in horizontal pipe runs with flanges installed so that the pressure taps are in a horizontal plane with the centerline of the pipe. Flow nozzles shall be installed for ease of accessibility for periodic maintenance. The differential pressure sensors shall be installed as close to the flow nozzle as possible.

#### 3.3.4.4 Turbine Meters

Turbine meters shall be installed so that the sensor is located in the center of the fluid flow pipe on the main axis.

#### 3.3.4.5 Vortex Shedding Flowmeters

The flowmeter shall be installed with its top above the pipeline in horizontal installations. The direction of flow shall be upward in vertical installations. The flowmeter shall be aligned to the direction of the flow, and shall be rigidly mounted and vibration free.

#### 3.3.4.6 Flow Switches

Flow switches shall be installed in such a manner as to minimize any disturbance in the flow of fluid while maintaining reliable operation of the switch.

#### 3.3.5 Electric Power Devices

##### 3.3.5.1 Potential Transformers

Potential transformers shall be installed in new cabinets as shown.

##### 3.3.5.2 Current Transformers

Current transformers shall be installed in new cabinets as shown.

##### 3.3.5.3 Meters

Kilojoule meters shall be installed in new cabinets as shown.



#### 3.3.5.4 Demand Meters

Kilojoule demand meters shall be installed in new cabinets as shown.

#### 3.3.5.5 Transducers

Kilojoule transducers shall be installed in new cabinets as shown.

#### 3.3.5.6 Current Sensing Relays

Relays shall be installed in new cabinets as shown.

#### 3.3.6 Floor Mounted Leak Detectors

Detectors shall be mounted per manufacturer's recommendation.

#### 3.3.7 Output Devices

##### 3.3.7.1 Relays and Contactors

Relays and contactors shall be installed in new cabinets.

##### 3.3.7.2 Electric Solenoid Operated Pneumatic Valve (EP)

EP valves shall be installed in new cabinets.

##### 3.3.7.3 Controllers

Controllers shall be installed in new control cabinets or as shown.

##### 3.3.7.4 Electric to Pneumatic (EP) Transducers

EP transducers shall be installed in new cabinets.

#### 3.3.8 Position Sensors

##### 3.3.8.1 End (Limit) Switch

Limit switch type and mounting shall be properly suited for the application to provide reliable switch operation.

##### 3.3.8.2 Potentiometers

Potentiometer type and mounting shall be properly suited for the application to provide reliable operation.

#### 3.3.9 Instrument Shelters

Instrument shelters shall be installed with the bottom 1.2 m above the supporting surface, using legs, and secured rigidly to minimize vibrations from winds. Instrument shelters shall be oriented facing north.

#### 3.3.10 Enclosures

All enclosure penetrations shall be from the bottom and shall be sealed to preclude entry of water using a silicone rubber sealant.

### 3.4 SITE TESTING

Site testing and adjustment of all equipment shall be performed in accordance with approved test procedures. The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all site testing. Test reports shall be submitted as specified.

#### 3.4.1 Site Demonstration Testing

Provide a detailed cross check of each EMCS sensor reading at the DTC and a separate independent instrument measuring the same medium or condition at the EMCS sensor installed location. Make a comparison of the values of the two readings to verify the EMCS sensor is functioning properly. DTM test shall include an ohm resistance check on each pair of wires in the completed new length of DTM. The integrity of the existing DTM cable loop along with the added cable shall continue to operate as before the new cable was added. Verify this integrity at the central console. The Contracting Officer will witness all field cross checking of sensors, controlled equipment, equipment status, wiring and DTM test. Include all test results in the test report. Test reports shall be submitted in booklet form, as specified.

SECTION 15190

IDENTIFICATION OF PIPING

PART 1 GENERAL (Not Applicable)

PART 2 PRODUCTS

2.1 PAINT FOR IDENTIFICATION BANDS AND BLOCKS

Bands or block paints shall be as specified in SECTION 09900 - PAINTING, GENERAL for the finish specified.

2.2 PRESSURE SENSITIVE PIPE MARKERS

At the option of the Contractor, pressure-sensitive pipe markers of the applicable size and color may be used.

2.3 BRASS TAGS

Where pipes are too small for such application, a brass identification tag shall be fastened securely at specified locations. Tags shall be 38 mm in diameter with depressed black figures 13 mm high.

PART 3 EXECUTION

3.1 APPLICATION

Bands and blocks shall be a minimum of two coats of gloss paint. Surface preparation, materials, and application of paint shall conform to the requirements of the SECTION: PAINTING, GENERAL. Color of bands or blocks shall be as specified hereinafter. Legends and bands or blocks shall be laced to be easily read from operating positions. Adjacent to legend, arrows shall be painted to indicate the direction of flow of material under normal operating conditions.

3.2 LOCATIONS

All piping in buildings and heating tunnels shall be identification painted with bands or blocks and legends of colors herein designated. Plumbing and heating piping in finished spaces such as offices and quarters shall not be color banded. Banding or blocking and legends shall be applied to the piping at locations as follows:

- a. Adjacent to each valve.
- b. Adjacent to each strainer.
- c. Each branch and riser at take-off.
- d. At each pipe passage through wall, floor and ceiling construction.
- e. At each pipe passage to underground.

f. At not more than 12 meter spacing on straight pipe runs.

### 3.3 BAND OR BLOCK AND LETTER SIZE

The band or block and letter sizes corresponding to the applicable outside diameter of pipe or pipe covering shall be used. Upper case letters and Arabic numerals shall be used. Sizes are as follows:

Outside Diameter of Pipe Covering (Inches)	Length of Color Band (inches)	Arrow Length x Width (Inches)	Size of Legend Letters and Numerals (Inches)
Less than 1-1/2	8	8 x 2-1/4	1/2
1-1/2 to 2-3/8	8	8 x 2-1/4	3/4
2-1/2 to 7-7/8	12	8 x 2-1/4	1-1/4
8 to 10	24	12 x 4-1/2	2-1/2
Over 10	32	12 x 4-1/2	3-1/2

### 3.4 LEGENDS

Applicable legends and bands or blocks shall be selected from the following:

<u>Material</u>	<u>Title</u>	<u>Color Band or Block</u>	
		<u>Letters</u>	<u>Background</u>
Natural Gas	Natural Gas(3)	Black	Yellow
Potable Water	Potable Water	Black	Green
Domestic Hot Water Supply	Dom. HW Sup. _____ deg C (2)	Black	Green
Domestic H.W. Recirc.	Dom. HW Rec. _____ deg C (2)	Black	Green
Compressed Air	(1)Comp. Air_____kPa	Black	Green
Fire Protection Water	Fire Protection Water	White	Red
Heating Water Supply	(2) Htg. Water Sup._____ deg C	Black	Yellow
Heating Water Return	(2) Htg. Water Ret. _____ deg C	Black	Yellow
Instrument Air	Instrument Air kPa	Black	Green
Makeup Water	Makeup Water	Black	Green
Raw Water	Raw Water	Black	Green
Chilled Water Supply	Chilled Water Supply	Black	Green
Chilled Water Return	Chilled Water Return	Black	Green
Condensate Drain Water	Cond. Drain Water	Black	Green
Treated Water	Treated Water	Black	Green
Refrigerant	Refrigerant	Black	Green

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- (1) Include maximum working pressure.
  - (2) Show the maximum working temperature.
  - (3) Exterior gas piping above grade shall have 25mm wide yellow bands painted on the piping or labeling as directed by the Contracting Officers Representative.

## SECTION 15250

## THERMAL INSULATION FOR MECHANICAL SYSTEMS

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. At the discretion of the government, the manufacturer of any material supplied will be required to furnish test reports pertaining to any of the tests necessary to assure compliance with the standard or standards referenced in this specification.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 167	(1996) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 580	(1995a) Stainless and Heat-Resisting Steel Wire
ASTM B 209	(1996) Aluminum and Aluminum-Alloy Sheet and Plate
ASTM C 195	(1990) Mineral Fiber Thermal Insulating Cement
ASTM C 449	(1995) Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement
ASTM C 533	(1985; R 1990) Calcium Silicate Block and Pipe Thermal Insulation
ASTM C 534	(1994) Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM C 547	(1995) Mineral Fiber Pipe Insulation
ASTM C 552	(1991) Cellular Glass Thermal Insulation
ASTM C 553	(1992) Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C 612	(1993) Mineral Fiber Block and Board Thermal Insulation
ASTM C 647	(1995) Properties and Tests of Mastics and Coating Finishes for Thermal Insulation
ASTM C 795	(1992) Thermal Insulation for Use in Contact With Austenitic Stainless Steel

ASTM C 871	(1995) Test Methods for Chemical Analysis of Thermal Insulation Materials for Leachable Chloride, Fluoride, Silicate, and Sodium Ions
ASTM C 916	(1985; Rev 1990) Adhesives for Duct Thermal Insulation
ASTM C 920	(1994) Elastomeric Joint Sealants
ASTM C 921	(1989 R; 1996) Determining the Properties of Jacketing Materials for Thermal Insulation
ASTM C 1126	(1989; R 1994) Specification for faced or Unfaced Rigid Cellular Phenolic Thermal Insulation
ASTM D 3278	(1989) Test Methods for Flash Point of Liquids by Setaflash Closed-Cup Apparatus
ASTM E 84	(1996a) Surface Burning Characteristics of Building Materials
ASTM E 96	(1995) Water Vapor Transmission of Materials

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS  
INDUSTRY (MSS)

MSS SP-69	(1996) Pipe Hangers and Supports - Selection and Application
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MIDWEST INSULATION CONTRACTORS ASSOCIATION (MICA)

MICA-01	(1993) National Commercial & Industrial Insulation Standards
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## 1.2 SYSTEM DESCRIPTION

Field-applied insulation and accessories on mechanical systems shall be as specified herein; factory-applied insulation is specified under the piping, duct or equipment to be insulated. Insulation of heat distribution systems and chilled water systems outside of buildings shall be as specified in Section 02698 PREFABRICATED UNDERGROUND HEATING/COOLING DISTRIBUTION SYSTEM. Field applied insulation materials required for use on Government-furnished items as listed in the SPECIAL CONTRACT REQUIREMENTS shall be furnished and installed by the Contractor.

## 1.3 GENERAL QUALITY CONTROL

### 1.3.1 Standard Products

Materials shall be the standard products of manufacturers regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

### 1.3.2 Installer's Qualifications

Qualified installers shall have successfully completed three or more similar type jobs within the last 5 years.

### 1.3.3 Surface Burning Characteristics

Unless otherwise specified, insulation not covered with a jacket shall have a flame spread rating no higher than 75 and a smoke developed rating no higher than 150. The outside surface of insulation systems which are located in air plenums, in ceiling spaces, and in attic spaces shall have a flame spread rating no higher than 25 and a smoke developed rating no higher than 50. Insulation materials located exterior to the building perimeter are not required to be fire-rated. Flame spread and smoke developed ratings shall be determined by ASTM E 84. Insulation shall be tested in the same density and installed thickness as the material that shall be used in the actual construction. Jackets shall comply with the flame spread and smoke developed ratings of 25/50 as determined by ASTM E 84.

### 1.3.4 Identification of Materials

Packages or standard containers of insulation, jacket material, cements, adhesives, and coatings delivered for use, and samples required for approval shall have manufacturer's stamp or label attached giving the name of the manufacturer and brand, and a description of the material.

## 1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

### SD-14 Samples

Thermal Insulation Materials; GA.

A complete list of materials, including manufacturer's descriptive technical literature, performance data, catalog cuts, and installation instructions. The product number, k-value, thickness and furnished accessories for each mechanical system requiring insulation shall be included. Materials furnished under this section of the specification shall be submitted at one time.

After approval of materials and prior to applying insulation a booklet shall be prepared and submitted for approval. The booklet shall contain marked-up MICA-01 plates (or detail drawings showing the insulation material and insulating system) for each pipe, duct, or piece of equipment which is/are required to be insulated per this specification. The MICA plates shall be marked-up showing the materials to be installed in accordance with the requirements of this specification for the specific insulation application. The Contractor shall submit all MICA Plates required to show the entire insulating system, including Plates required to show insulation penetrations, vessel bottom and top heads, legs, and skirt insulation as applicable. If the Contractor elects to submit detailed drawings instead of marked-up MICA Plates, the detail drawings shall show cut-away, section views, and details indicating each component of the insulation system and

showing provisions for insulating jacketing, and sealing portions of the equipment. For each type of insulation installation on the drawings, provide a label which identifies each component in the installation (i.e., the duct, insulation, adhesive, vapor retarder, jacketing, tape, mechanical fasteners, etc.) Indicate insulation by type and manufacturer. Three copies of the booklet shall be submitted at the jobsite to the Contracting Officer. One copy of the approved booklet shall remain with the insulation Contractor's display sample and two copies shall be provided for Government use.

After approval of materials actual sections of installed systems properly insulated in accordance with the specification requirements shall be displayed. Such actual sections must remain accessible to inspection throughout the job and will be reviewed from time to time for controlling the quality of the work throughout the construction site. Each material used shall be identified, by indicating on an attached sheet the specification requirement for the material and the material by each manufacturer intended to meet the requirement. Display sample sections will be inspected at the jobsite by the Contracting Officer. Approved display sample sections shall remain on display at the jobsite during the construction period. Upon completion of construction, the display sample sections will be closed and sealed.

Pipe Insulation Display Sections: Display sample sections shall include as a minimum an elbow or tee, a valve, dielectric unions and flanges, a hanger with protection shield and insulation insert, or dowel as required, at support point, method of fastening and sealing insulation at longitudinal lap, circumferential lap, butt joints at fittings and on pipe runs, and terminating points for each type of pipe insulation used on the job, and for hot pipelines and cold pipelines, both interior and exterior, even when the same type of insulation is used for these services.

Duct Insulation Display Sections: Display sample sections for rigid and flexible duct insulation used on the job. A display section for duct insulation exposed to weather shall be protected by enclosing with a temporary covering.

## 1.5 STORAGE

Materials shall be delivered in the manufacturer's unopened containers. Materials delivered and placed in storage shall be provided with protection from weather, humidity, dirt, dust and other contaminants by the Contractor. Insulation material and supplies that become dirty, dusty, wet, or otherwise contaminated may be rejected by the Contracting Officer.

## 2 PRODUCTS

### 2.1 GENERAL MATERIALS

Materials shall be compatible and shall not contribute to corrosion, soften, or otherwise attack surfaces to which applied in either the wet or dry state. Materials to be used on stainless steel surfaces shall meet ASTM C 795 requirements. Materials shall be asbestos free and conform to the following:



### 2.1.1 Adhesives

#### 2.1.1.1 Acoustical Lining Insulation Adhesive

Insulation shall be applied in cut-to-size pieces attached to the interior of the duct with a nonflammable, fire-resistant adhesive conforming to ASTM C 916, Type I. Exposed edges of the liner at the duct ends and at other joints where the lining will be subject to erosion shall be coated with a heavy brush coat of the nonflammable, fire-resistant adhesive to prevent delamination of glass fibers.

#### 2.1.1.2 Mineral Fiber Insulation Cement

Cement shall be in accordance with ASTM C 195.

#### 2.1.1.3 Lagging Adhesive

Lagging adhesives shall be nonflammable and fire-resistant and shall have flame spread and smoke developed ratings of 25/50 when measured in accordance with ASTM E 84. Adhesives shall be either the Class 1 or Class 2 type as defined here. Class 1 adhesive shall be pigmented [white] [red] and be suitable for bonding fibrous glass cloth to faced and unfaced fibrous glass insulation board; for bonding cotton brattice cloth to faced and unfaced fibrous glass insulation board; for sealing edges of and bounding fibrous glass tape to joints of fibrous glass board; or for bonding lagging cloth to thermal insulation. Class 2 adhesive shall be pigmented white and be suitable for attaching fibrous glass insulation to metal surfaces. Lagging adhesives shall be applied in strict accordance with the manufacturer's recommendations.

#### 2.1.2 Contact Adhesive

Adhesive may be dispersed in a nonhalogenated organic solvent with a low flash point (flash point less than minus 3.9 degrees C when tested in accordance with ASTM D 3278) or, dispersed in a nonflammable organic solvent which shall not have a fire point below 94 degrees C. The adhesive shall not adversely affect, initially or in service, the insulation to which it is applied, nor shall it cause any corrosive effect on metal to which it is applied. Any solvent dispersing medium or volatile component of the adhesive shall have no objectionable odor and shall not contain any benzene or carbon tetrachloride. The dried adhesive shall not omit nauseous, irritating, or toxic volatile matters or aerosols when the adhesive is heated to any temperature up to 100 degrees C. The adhesive shall be nonflammable and fire resistant.

#### 2.1.3 Caulking

ASTM C 920, Type S, Grade NS, Class 25, Use A.

#### 2.1.4 Corner Angles

Nominal 0.4060 mm aluminum 25 x 25 mm with factory applied kraft backing. Aluminum shall be ASTM B 209, Alloy 3003, 3105, or 5005.

#### 2.1.5 Finishing Cement

Mineral fiber hydraulic-setting thermal insulating cement ASTM C 449.

#### 2.1.6 Fibrous Glass Cloth and Glass Tape

Fibrous glass cloth and glass tape shall have flame spread and smoke developed ratings of no greater than 25/50 when measured in accordance with ASTM E 84. Fibrous glass cloth and tape; 20 x 20 maximum size mesh. Tape shall be 100 mm wide rolls. Class 3 tape shall be 0.15 kg per square meter.

#### 2.1.7 Staples

Outward clinching type ASTM A 167, Type 304 or 316 stainless steel.

#### 2.1.8 Jackets

ASTM C 921, Type I, maximum moisture vapor transmission 0.02 perms, minimum puncture resistance 50 Beach units on all surfaces except concealed ductwork, where a minimum puncture resistance of 25 Beach units is acceptable. Minimum tensile strength, 6.1 N/mm width. ASTM C 921, Type II, minimum puncture resistance 25 Beach units, tensile strength minimum 3.5 N/mm width. Jackets used on insulation exposed in finished areas shall have white finish suitable for painting without sizing.

##### 2.1.8.1 White Vapor Retarder ASJ (All Service Jacket)

For use on hot/cold pipes, ducts, or equipment. Vapor retarder jackets used on insulation exposed in finished areas shall have white finish suitable for painting without sizing.

##### 2.1.8.2 Aluminum Jackets

Aluminum jackets shall be corrugated, embossed or smooth sheet, 0.4060 mm nominal thickness; ASTM B 209, Temper H14, Temper H16, Alloy 3003, 5005, or 3105 with factory applied moisture retarder. Corrugated aluminum jacket shall not be used outdoors. Aluminum jacket securing bands shall be Type 304 stainless steel, 0.3960 mm thick, 12.7 mm wide for pipe under 300 mm diameter and 19.1 mm wide for pipe over 300 mm diameter. Aluminum jacket circumferential seam bands shall be 50.8 x 0.4060 mm aluminum matching jacket material. Bands for insulation below ground shall be 19.1 x 0.5080 mm thick stainless steel, or fiberglass reinforced tape. The jacket may, at the option of the Contractor, be provided with a factory fabricated Pittsburgh or "Z" type longitudinal joint. When the "Z" joint is used, the bands at the circumferential joints shall be designed by the manufacturer to seal the joints and hold the jacket in place.

##### 2.1.8.3 Polyvinyl Chloride (PVC) Jackets

Polyvinyl chloride (PVC) jacket and fitting covers shall have high impact strength, UV resistant rating or treatment and moderate chemical resistance with minimum thickness 0.7620 mm. Insulation under PVC jacket shall meet jacket manufacturer's written recommendations.

#### 2.1.9 Vapor Retarder Coating

The vapor retarder coating shall be fire and water resistant and appropriately selected for either outdoor or indoor service. Color shall be white. The water vapor permeance of the compound shall not exceed 0.05 perm and shall be determined according to procedure B of ASTM E 96 utilizing

apparatus described in ASTM E 96. The coating shall be a nonflammable, fire resistant type. The flash point of the compound shall not be less than 26.7 degrees C and shall be determined in accordance with ASTM D 3278. All other application and service properties shall be in accordance with ASTM C 647.

#### 2.1.10 Wire

Soft annealed ASTM A 580 Type 302, 304 or 316 stainless steel, 16 or 18 gauge.

### 2.2 PIPE INSULATION MATERIALS

Pipe insulation materials shall be as follows:

#### 2.2.1 Aboveground Cold Pipeline

Insulation for minus 34 degrees C to plus 16 degrees C shall be as follows:

##### 2.2.1.1 Cellular Glass

ASTM C 552, Type II, and Type III.

##### 2.2.1.2 Flexible Cellular Insulation

ASTM C 534, Type I or II. Type II shall have vapor retarder skin on both sides of the insulation.

##### 2.2.1.3 Phenolic Insulation

ASTM C 1126, Type III. A maximum allowable leachable chloride content shall comply with ASTM C 795 when tested in accordance with ASTM C 871.

#### 2.2.2 Aboveground Hot Pipeline

For aboveground hot pipeline above 16 degrees C insulation the following requirements shall be met.

##### 2.2.2.1 Mineral Fiber

ASTM C 547, Class 1 or Class 2 as required for the operating temperature range.

##### 2.2.2.2 Calcium Silicate

ASTM C 533, Type I indoor only, or outdoors above 121 degrees C pipe temperature.

##### 2.2.2.3 Cellular Glass

ASTM C 552, Type II and Type III.

##### 2.2.2.4 Flexible Cellular Insulation

ASTM C 534, Type I or II to 93 degrees C service.

#### 2.2.2.5 Phenolic Insulation

ASTM C 1126 Type III to 121 C service. A maximum allowable leachable chloride content shall comply with ASTM C 795 when tested in accordance with ASTM C 871.

#### 2.2.3 Below ground Pipeline Insulation

ASTM C 552, Type II.

### 2.3 DUCT INSULATION MATERIALS

Duct insulation materials shall be as follows:

#### 2.3.1 Rigid Mineral Fiber

ASTM C 612, Class 1.

#### 2.3.2 Flexible Mineral Fiber

ASTM C 553, Type I, Class B-2.

#### 2.3.3 Cellular Glass

ASTM C 552, Type I.

#### 2.3.4 Phenolic Foam

ASTM C 1126 Type II. A maximum allowable leachable chloride content shall comply with ASTM C 795 when tested in accordance with ASTM C 871.

#### 2.3.5 Flexible Cellular

ASTM C 534 Type II.

### 2.4 EQUIPMENT INSULATION MATERIALS

Equipment insulation materials shall be as follows:

#### 2.4.1 Cold Equipment Insulation

For temperatures below 16 degrees C.

##### 2.4.1.1 Cellular Glass

ASTM C 552, Type I, Type III, or Type IV as required.

##### 2.4.1.2 Flexible Cellular Insulation

ASTM C 534, Type II.

##### 2.4.1.3 Phenolic Foam

ASTM C 1126 Type II. A maximum allowable leachable chloride content shall comply with ASTM C 795 when tested in accordance with ASTM C 871.

#### 2.4.2 Hot Equipment Insulation

For temperatures above 16 degrees C.

##### 2.4.2.1 Rigid Mineral Fiber

ASTM C 612, Type 2, 3, 4 or 5 as required for temperature encountered to 982 degrees C.

##### 2.4.2.2 Flexible Mineral Fiber

ASTM C 553, Type 1, 2, 3, 4, 5, 6, or 7 as required for temperature encountered to 649 degrees C.

##### 2.4.2.3 Calcium Silicate

ASTM C 533, Type I, indoors only, or outdoors above 121 degrees C. Pipe shape may be used on diesel engine exhaust piping and mufflers to 649 degrees C.

##### 2.4.2.4 Cellular Glass

ASTM C 552, Type I, Type III, or Type IV as required.

##### 2.4.2.5 Flexible Cellular Insulation

ASTM C 534, Type II, to 93 degrees C.

##### 2.4.2.6 Phenolic Foam

ASTM C 1126 Type II to 121 degrees C. A maximum allowable leachable chloride content shall comply with ASTM C 795 when tested in accordance with ASTM C 871.

### 3 EXECUTION

#### 3.1 APPLICATION - GENERAL

##### 3.1.1 Installation

Except as otherwise specified, material shall be installed in accordance with the manufacturer's written instructions. Insulation materials shall not be applied until tests specified in other sections of this specification are completed. Material such as rust, scale, dirt and moisture shall be removed from surfaces to receive insulation. Insulation shall be kept clean and dry. Insulation shall not be removed from its shipping containers until the day it is ready to use and shall be returned to like containers or equally protected from dirt and moisture at the end of each workday. Insulation that becomes dirty shall be thoroughly cleaned prior to use. If insulation becomes wet or if aforementioned cleaning does not restore the surfaces to like new condition, the insulation will be rejected, and shall be immediately removed from the jobsite. Joints shall be staggered on multi layer insulation. Mineral fiber thermal insulating cement shall be mixed with demineralized water when used on stainless steel surfaces. Insulation, jacketing and accessories shall be installed in accordance with MICA-01 standard plates except where modified herein or on the drawings.

### 3.1.2 Fire stopping

Where pipes and ducts pass through fire walls, fire partitions, above grade floors, and fire rated chase walls, the penetration shall be sealed with Fire stopping materials as specified in Section 07270 FIRE STOPPING.

### 3.1.3 Painting and Finishing

Painting shall be as specified in Section 09900 PAINTING, GENERAL.

### 3.1.4 Flexible Cellular Insulation

Flexible cellular insulation shall be installed with seams and joints sealed with a contact adhesive. Flexible cellular insulation shall not be used on surfaces greater than 93 degrees C. Seams shall be staggered when applying multiple layers of insulation. Insulation exposed to weather and not shown to have jacketing shall be protected with two coats of UV resistant finish as recommended by the manufacturer after the adhesive is dry.

### 3.1.5 Welding

No welding shall be done on piping, duct or equipment without written approval of the Contracting Officer. The capacitor discharge welding process may be used for securing metal fasteners to duct.

### 3.1.6 Pipes/Ducts/Equipment which Require Insulation

Insulation is required, unless stated otherwise, on all pipes, ducts, or equipment, which operate at or below 15.6 C and at or above 26.7 C.

## 3.2 PIPE INSULATION INSTALLATION

### 3.2.1 Pipe Insulation

#### 3.2.1.1 General

Pipe insulation shall be installed on aboveground hot and cold pipeline systems as specified below to form a continuous thermal retarder, including straight runs, fittings and appurtenances unless specified otherwise. Installation shall be with full length units of insulation and using a single cut piece to complete a run. Cut pieces or scraps abutting each other shall not be used. Pipe insulation shall be omitted on the following:

- a. Pipe used solely for fire protection.
- b. Chromium plated pipe to plumbing fixtures. However, fixtures for use by the physically handicapped shall have the hot water supply and drain, including the trap, insulated where exposed.
- c. Sanitary drain lines, except those draining HVAC coil condensate shall be insulated as required for cold pipelines.
- d. Unions in pipe above 16 degrees C.
- e. Strainers in pipe above 16 degrees C.
- f. Check valves in pipe above 16 degrees C.

- g. Air chambers.

#### 3.2.1.2 Pipes Passing Through Sleeves

- a. Pipe insulation shall be continuous through the sleeve.
- b. An aluminum jacket with factory applied moisture retarder shall be provided over the insulation wherever penetrations require sealing.
- c. Where penetrating interior walls, the aluminum jacket shall extend 50 mm beyond either side of the wall and shall be secured on each end with a band.
- d. Where penetrating floors, the aluminum jacket shall extend from a point below the backup material to a point 250 mm above the floor with one band at the floor and one not more than 25 mm from the end of the aluminum jacket.
- e. Where penetrating waterproofed floors, the aluminum jacket shall extend from below the backup material to a point 50 mm above the flashing with a band 25 mm from the end of the aluminum jacket.
- f. Where penetrating exterior walls, the aluminum jacket required for pipe exposed to weather shall continue through the sleeve to a point 50 mm beyond the interior surface of the wall.
- g. Where penetrating roofs, pipe shall be insulated as required for interior service to a point flush with the top of the flashing and sealed with vapor retarder coating. The insulations for exterior application shall butt tightly to the top of flashing and interior insulation. The exterior aluminum jacket shall extend 50 mm down beyond the end of the insulation to form a counter flashing. The flashing and counter flashing shall be sealed underneath with caulking.
- h. In high abuse areas such as janitor closets and traffic areas in equipment rooms, kitchens, and mechanical rooms, user storage rooms, aluminum jackets shall be utilized. Pipe insulation to the 2 meter level shall be protected.

#### 3.2.1.3 Pipes Passing Through Hangers

- a. Insulation, whether hot or cold application, shall be continuous through hangers. All horizontal pipes 50 mm and smaller shall be supported on hangers with the addition of a Type 40 protection shield to protect the insulation in accordance with MSS SP-69. Whenever insulation shows signs of being compressed, or when the insulation or jacket shows visible signs of distortion at or near the support shield, insulation inserts as specified below for piping larger than 50 mm shall be installed.
- b. Horizontal pipes larger than 50 mm at 16 degrees C and above shall be supported on hangers in accordance with MSS SP-69, and Section 15400 PLUMBING, GENERAL PURPOSE.

- c. Horizontal pipes larger than 50 mm below 16 degrees C shall be supported on hangers with the addition of a Type 40 protection shield in accordance with MSS SP-69. An insulation insert of cellular glass or calcium silicate shall be installed above each shield. The insert shall cover not less than the bottom 180 degree arc of the pipe. Inserts shall be the same thickness as the insulation, and shall extend 50 mm on each end beyond the protection shield. When insulation inserts are required per the above, and the insulation thickness is less than 25 mm, wooden or cork dowels or blocks may be installed between the pipe and the shield to prevent the weight of the pipe from crushing the insulation as an option to installing insulation inserts. The insulation jacket shall be continuous over the wooden dowel, wooden block, or insulation insert.
- d. Vertical pipes shall be supported with either Type 8 or Type 42 riser clamps with the addition of two Type 40 protection shields in accordance with MSS SP-69 covering the 360 degree arc of the insulation. An insulation insert of cellular glass or calcium silicate shall be installed between each shield and the pipe. The insert shall cover the 360 degree arc of the pipe. Inserts shall be the same thickness as the insulation, and shall extend 50 mm on each end beyond the protection shield. When insulation inserts are required per the above, and the insulation thickness is less than 25 mm, wooden or cork dowels or blocks may be installed between the pipe and the shield to prevent the hanger from crushing the insulation as an option instead of installing insulation inserts. The insulation jacket shall be continuous over the wooden dowel, wooden block, or insulation insert. The vertical weight of the pipe shall be supported with hangers located in a horizontal section of the pipe. When the pipe riser is longer than 9 m, the weight of the pipe shall be additionally supported with hangers in the vertical run of the pipe which are directly clamped to the pipe, penetrating the pipe insulation. These hangers shall be insulated and the insulation jacket sealed as indicated herein for anchors in a similar service.
- e. Inserts shall be covered with a jacket material of the same appearance and quality as the adjoining pipe insulation jacket, shall overlap the adjoining pipe jacket 38 mm, and shall be sealed as required for the pipe jacket. The jacket material used to cover inserts in flexible cellular insulation shall conform to ASTM C 921, Type 1, and is allowed to be of a different material than the adjoining insulation material.

#### 3.2.1.4 Pipes Passing Through Walls

- a. For hot water pipes supplying lavatories or other similar heated service which requires insulation, the insulation shall be terminated on the backside of the finished wall. The insulation termination shall be protected with two coats of vapor barrier coating with a minimum total thickness of 2.0 mm applied with glass tape embedded between coats (if applicable). The coating shall extend out onto the insulation 51.0 mm and shall seal the end of the insulation. Glass tape seams shall overlap 25 mm. Caulk the annular space between the pipe and wall penetration. Cover the pipe and wall penetration with a properly sized (well fitting)



escutcheon plate. The escutcheon plate shall overlap the wall penetration at least 10 mm.

- b. For domestic cold water pipes requiring insulation, the insulation shall be terminated on the finished side of the wall (i.e. insulation must cover the pipe throughout the wall penetration). The insulation shall be protected with two coats of vapor barrier coating with a minimum total thickness of 2.0 mm. The coating shall extend out onto the insulation 51.0 mm and shall seal the end of the insulation. Caulk the annular space between the pipe and wall penetration. Cover the pipe and wall penetration with a properly sized (well fitting) escutcheon plate. The escutcheon plate shall overlap the wall penetration by at least 10 mm.

#### 3.2.1.5 Flexible Cellular Pipe Insulation

Flexible cellular pipe insulation shall be tubular form for pipe sizes 150 mm and less. Type II sheet insulation used on pipes larger than 150 mm shall not be stretched around the pipe. On pipes larger than 300 mm, adhere insulation directly to the pipe on the lower 1/3 of the pipe. Seams shall be staggered when applying multiple layers of insulation. Sweat fittings shall be insulated with miter-cut pieces the same size as on adjacent piping. Screwed fittings shall be insulated with sleeved fitting covers fabricated from miter-cut pieces and shall be overlapped and sealed to the adjacent pipe insulation.

#### 3.2.2 Aboveground Cold Pipelines

The following shall be included for aboveground cold pipelines minus 34 degrees C to plus 16 degrees C:

- a. Domestic cold and chilled drinking water.
- b. Make-up water.
- c. Horizontal and vertical portions of interior roof drains.
- d. Refrigerant suction lines.
- e. Chilled water, including valves, valve packages, flexible connectors and all piping items including pete's plug stems, thermometer stems up to base of thermometer face, up to base of gages, balancing valves, strainers, unions. The only accessories left uncovered may be valve handles. For Fan coil units, all valve handles on chilled water systems shall be installed above an insulated drain pan. Fan coil unit piping at the unit shall be insulated with flexible cellular foam insulation with thickness and U-value as required by the tables herein.
- f. Air conditioner condensate drains.

##### 3.2.2.1 Insulation Thickness

Insulation thickness for cold pipelines shall be determined using Table I at the end of this section.

### 3.2.2.2 Jacket for Fibrous, Cellular Glass, and Phenolic Foam Insulated Pipe

Insulation shall be covered with a factory applied vapor retarder jacket or field applied seal welded PVC jacket. Insulation inside the building shown to be protected with an aluminum jacket shall have the insulation and vapor retarder jacket installed as specified herein. The aluminum jacket shall be installed as specified for piping exposed to weather, except sealing of the laps of the aluminum jacket is not required. In high abuse areas such as janitor closets and traffic areas in equipment rooms, kitchens, and mechanical rooms, aluminum jackets shall be utilized. Pipe insulation to the 2.0 meter level will be protected.

### 3.2.2.3 Insulation for Straight Runs (Fibrous, Cellular Glass and Phenolic Foam)

- a. Insulation shall be applied to the pipe with joints tightly butted. The ends of fibrous insulation shall be sealed off with vapor retarder coating at intervals not to exceed 4.5 m.
- b. Longitudinal laps of the jacket material shall overlap not less than 38 mm. Butt strips 75 mm wide shall be provided for circumferential joints.
- c. Laps and butt strips shall be secured with adhesive and stapled on 100 mm centers if not factory self-sealing.
- d. Factory self-sealing lap systems may be used when the ambient temperature is between 4 degrees C and 50 degrees C during installation. The lap system shall be installed in accordance with manufacturer's recommendations. Stapler shall be used only if specifically recommended by the manufacturer. Where gaps occur, the section shall be replaced or the gap repaired by applying adhesive under the lap and then stapling.
- e. All Staples, including those used to repair factory self-seal lap systems, shall be coated with a vapor retarder coating. All seams, except those on factory self-seal systems shall be coated with vapor retarder coating.
- f. Breaks and punctures in the jacket material shall be patched by wrapping a strip of jacket material around the pipe and securing it with adhesive, stapling, and coating with vapor retarder coating. The patch shall extend not less than 38 mm past the break.
- g. At penetrations such as thermometers, the voids in the insulation shall be filled and sealed with vapor retarder coating.

### 3.2.2.4 Insulation for Fittings and Accessories

- a. Pipe insulation shall have ends thoroughly coated with a vapor retarder coating not less than 150 mm from each flange, union, valve, anchor, or fitting in all directions.
- b. Precut, preformed insulation for placement over fittings, flanges, unions, valves, anchors, and mechanical couplings shall be used. Precut, preformed insulation shall exhibit the same properties as the adjoining pipe insulation. Where precut/preformed is

unavailable, rigid preformed pipe insulation sections may be segmented into the shape required. Insulation of the same thickness and conductivity as the adjoining pipe insulation shall be used. If nesting size insulation is used, the insulation should be overlapped 50 mm or one pipe diameter. Loose fill mineral fiber or insulating cement shall be used to fill the voids. Elbows insulated using segments shall not have less than 3 segments per elbow.

- c. Upon completion of installation of insulation on flanges, unions, valves, anchors, fittings and accessories, terminations and insulation not protected by factory vapor retarder jackets or PVC fitting covers shall be protected with two coats of vapor retarder coating with a minimum total thickness of 2.0 mm, applied with glass tape embedded between coats. Tape seams shall overlap 25 mm. The coating shall extend out onto the adjoining pipe insulation 50 mm.
- d. Anchors attached directly to the pipe shall be insulated for a sufficient distance to prevent condensation but not less than 150 mm from the insulation surface.
- e. Flexible connections at pumps and other equipment shall be insulated with 15 mm flexible cellular insulation, unless otherwise indicated.
- f. Insulation shall be marked showing the location of unions, strainers, and check valves.

#### 3.2.2.5 Optional PVC Fitting Covers

At the option of the Contractor, premolded, one or two piece PVC fitting covers may be used in lieu of the vapor retarder and embedded glass tape. Factory premolded insulation segments shall be used under the fitting covers for elbows. Insulation segments shall be the same thickness as adjoining pipe insulation and the insulation shall be protected with one coat of vapor retarder coating under the PVC cover. The covers shall be secured by PVC vapor retarder tape, adhesive, seal-welding or with tacks made for securing PVC covers. Seams in the cover, and tacks and laps to adjoining pipe insulation jacket, shall be sealed with vapor retarder tape to ensure that the assembly has a continuous vapor seal.

#### 3.2.3 Aboveground Hot Pipelines

For hot pipelines above 16 degrees C the following shall be included:

- a. Domestic hot water.
- b. Hot water heating.

##### 3.2.3.1 Insulation Thickness

Insulation thickness for hot pipelines shall be determined using Table II at the end of this section.

### 3.2.3.2 Jacket for Insulated Pipe

Insulation shall be covered, in accordance with manufacturer's recommendations, with a factory applied Type II jacket or field applied aluminum where required or seal welded PVC.

### 3.2.3.3 Insulation for Straight Runs

- a. Insulation shall be applied to the pipe with joints tightly butted.
- b. Longitudinal laps of the jacket material shall overlap not less than 38 mm, and butt strips 75 mm wide shall be provided for circumferential joints.
- c. Laps and butt strips shall be secured with adhesive and stapled on 100 mm centers if not factory self-sealing. Adhesive may be omitted where pipe is concealed.
- d. Factory self-sealing lap systems may be used when the ambient temperature is between 4 degrees C and 49 degrees C and shall be installed in accordance with manufacturer's instructions. Laps and butt strips shall be stapled whenever there is nonadhesion of the system. Where gaps occur, the section shall be replaced or the gap repaired by applying adhesive under the lap and then stapling.
- e. Breaks and punctures in the jacket material shall be patched by wrapping a strip of jacket material around the pipe and be secured with adhesive and stapled on 100 mm centers if not factory self-sealing. Adhesive may be omitted where pipe is concealed. Patch shall extend not less than 38 mm past the break.
- f. Install flexible cellular pipe insulation by slitting tubular sections and applying onto piping or tubing. Alternately, whenever possible, slide unslit sections over the open ends of piping or tubing. All seams and butt joints shall be secured and sealed with adhesive. When using self-seal products only the butt joints shall be secured with adhesive. Insulation shall be pushed on the pipe, never pulled. Stretching of insulation may result in open seams and joints. All edges shall be clean cut. Rough or jagged edges of the insulation shall not be permitted. Proper tools such as sharp knives must be used. Type II sheet insulation when used on pipe larger than 150 mm shall not be stretched around the pipe. On pipes larger than 300 mm, adhere sheet insulation directly to the pipe on the lower 1/3 of the pipe.

### 3.2.3.4 Insulation for Fittings and Accessories

- a. The run of the line pipe insulation shall have the ends brought up to the item.
- b. Insulation of the same thickness and conductivity as the adjoining pipe insulation, either premolded or segmented, shall be placed around the item abutting the adjoining pipe insulation, or if nesting size insulation is used, overlapping 50 mm or one pipe diameter. Loose fill mineral fiber or insulating cement shall be used to fill the voids. Insulation for elbows less than 80 mm size shall be premolded. Insulation for elbows 80 mm size and

larger shall be either premolded or segmented. Elbows insulated using segments shall have not less than 3 segments per elbow. Insulation may be wired or taped on until finish is applied.

- c. Upon completion of installation of insulation on flanges, unions, valves, anchors, fittings and accessories, terminations and insulation not protected by factory vapor retarder jackets or PVC fitting covers shall be protected with two coats of Class 1 adhesive applied with glass tape embedded between coats. Tape seams shall overlap 25 mm. Adhesive shall extend onto the adjoining insulation not less than 50 mm. The total dry film thickness shall be not less than 2.0 mm.
- d. Insulation terminations shall be tapered to unions at a 45-degree angle.
- e. At the option of the Contractor, factory premolded one- or two-piece PVC fitting covers may be used in lieu of the adhesive and embedded glass tape. Factory premolded segments or factory or field cut blanket insert insulation segments shall be used under the cover and shall be the same thickness as adjoining pipe insulation. The covers shall be secured by PVC vapor retarder tape, adhesive, seal-welding or with tacks made for securing PVC covers.

#### 3.2.4 Piping Exposed to Weather

Piping exposed to weather shall be insulated and jacketed as specified for the applicable service inside the building. After this procedure, an aluminum jacket shall be applied. PVC jacketing requires no factory applied jacket beneath it. Flexible cellular insulation exposed to weather shall be treated in accordance with paragraph FLEXIBLE CELLULAR INSULATION.

##### 3.2.4.1 Aluminum Jacket

The jacket for hot piping may be factory applied. The jacket shall overlap not less than 50 mm at longitudinal and circumferential joints and shall be secured with bands at not more than 300 mm centers. Longitudinal joints shall be overlapped down to shed water and located at 4 or 8 o'clock positions. Joints on piping 16 degrees C and below shall be sealed with caulking while overlapping to prevent moisture penetration. Where jacketing on piping 16 degrees C and below abuts an uninsulated surface, joints shall be caulked to prevent moisture penetration. Joints on piping above 16 degrees C shall be sealed with a moisture retarder.

##### 3.2.4.2 Insulation for Fittings

Flanges, unions, valves, fittings, and accessories shall be insulated and finished as specified for the applicable service. Two coats of an emulsion type weatherproof mastic recommended by the insulation manufacturer shall be applied with glass tape embedded between coats. Tape overlaps shall be not less than 25 mm and the adjoining aluminum jacket not less than 50 mm. Factory preformed aluminum jackets may be used in lieu of the above. Molded PVC fitting covers shall be used with PVC lagging and adhesive welded moisture tight.

#### 3.2.4.3 PVC Lagging

PVC lagging shall be ultraviolet resistant and adhesive welded vapor tight with manufacturer's recommended adhesive. Installation shall include provision for thermal expansion.

#### 3.2.5 Below ground Pipe Insulation

See Section PREFABRICATED UNDERGROUND HEATING/COOLING DISTRIBUTION SYSTEM.

### 3.3 DUCT INSULATION INSTALLATION

Corner angles shall be installed on external corners of insulation on ductwork in exposed finished spaces before covering with jacket.

#### 3.3.1 Duct Insulation Thickness

Duct insulation thickness shall be in accordance with Table III at the end of this section.

#### 3.3.2 Insulation and Vapor Retarder for Cold Air Duct

Insulation and vapor retarder for cold air duct below 16 degrees C: Ducts and associated equipment shall be insulated to a thickness which is in accordance with Table III. The following shall be insulated:

- a. Supply ducts.
- b. Return air ducts.
- c. Relief ducts.
- d. Flexible runouts (field-insulated).
- e. Plenums.
- f. Duct-mounted coil casings.
- g. Coil headers and return bends.
- h. Coil casings.
- i. Fresh air intake ducts.
- j. Filter boxes.
- k. Mixing boxes (field-insulated).
- l. Supply fans (field-insulated).

Insulation for rectangular ducts shall be flexible type where concealed, minimum density 12 kg per cubic meter and rigid type where exposed, minimum density 48 kg per cubic meter. Insulation for round/oval ducts shall be flexible type, minimum density 12 kg per cubic meter with a factory Type I jacket; or, a semi rigid board, minimum density 48 kg per cubic meter, formed or fabricated to a tight fit, edges beveled and joints tightly butted and staggered, with a factory applied Type I all service jacket. Insulation for exposed ducts shall be provided with either a white, paintable, factory-

applied Type I jacket or a vapor retarder jacket coating finish as specified. Fibrous and cellular glass insulation on concealed duct shall be provided with a factory-applied Type I vapor retarder jacket. The total dry film thickness shall be approximately 2.0 mm. Duct insulation shall be continuous through sleeves and prepared openings except fire wall penetrations. Duct insulation terminating at fire dampers, shall be continuous over the damper collar and retaining angle of fire dampers, which are exposed to unconditioned air and which may be prone to condensate formation. Duct insulation and vapor retarder shall cover the collar, neck, and any uninsulated surfaces of diffusers, registers and grills. Vapor retarder materials shall be applied to form a complete unbroken vapor seal over the insulation.

#### 3.3.2.1 Installation on Concealed Duct

- a. For rectangular, oval or round ducts, insulation shall be attached by applying Class 2 adhesive around the entire perimeter of the duct in 150 mm wide strips on 300 mm centers.
- b. For rectangular and oval ducts, 600 mm and larger insulation shall be additionally secured to bottom of ducts by the use of mechanical fasteners. Fasteners shall be spaced on 450 mm centers and not more than 450 mm from duct corners.
- c. For rectangular, oval and round ducts, mechanical fasteners shall be provided on sides of duct risers for all duct sizes. Fasteners shall be spaced on 450 mm centers and not more than 450 mm from duct corners.
- d. Insulation shall be impaled on the mechanical fasteners where used and shall be pressed thoroughly into the adhesive. Care shall be taken to ensure vapor retarder jacket joints overlap 50 mm. The insulation shall not be compressed to a thickness less than that specified. Insulation shall be carried over standing seams and trapeze-type duct hangers.
- e. Self-locking washers shall be installed where mechanical fasteners are used. The pin shall be trimmed back and bent over.
- f. Jacket overlaps shall be secured under the overlap with Class 2 adhesive and stapled on 100 mm centers. Staples and seams shall be coated with a brush coat of vapor retarder coating.
- g. Breaks in the jacket material shall be covered with patches of the same material as the vapor retarder. The patches shall extend not less than 50 mm beyond the break or penetration in all directions and shall be secured with Class 2 adhesive and staples. Staples and joints shall be sealed with a brush coat of vapor retarder coating.
- h. At jacket penetrations such as hangers thermometers and damper operating rods, voids in the insulation shall be filled and the penetration sealed with a brush coat of vapor retarder coating.
- i. Insulation terminations and pin punctures shall be sealed and flashed with a reinforced vapor retarder coating finish. The coating shall overlap the adjoining insulation and uninsulated

surface 50 mm. Pin puncture coatings shall extend 50 mm from the puncture in all directions.

- j. Where insulation standoff brackets occur, insulation shall be extended under the bracket and the jacket terminated at the bracket.

#### 3.3.2.2 Installation on Exposed Duct Work

- a. For rectangular ducts, rigid insulation shall be secured to the duct by mechanical fasteners on all four sides of the duct, spaced not more than 300 mm apart and not more than 75 mm from the edges of the insulation joints. A minimum of two rows of fasteners shall be provided for each side of duct 300 mm and larger. One row shall be provided for each side of duct less than 300 mm.
- b. Duct insulation shall be formed with minimum jacket seams. Each piece of rigid insulation shall be fastened to the duct using mechanical fasteners. When the height of projections is less than the insulation thickness, insulation shall be brought up to standing seams, reinforcing, and other vertical projections and shall not be carried over. Vapor retarder jacket shall be continuous across seams, reinforcing, and projections. When height of projections is greater than the insulation thickness, insulation and jacket shall be carried over.
- c. Insulation shall be impaled on the fasteners; self-locking washers shall be installed and the pin trimmed and bent over.
- d. Joints in the insulation jacket shall be sealed with a 100 mm wide strip of the same material as the vapor retarder jacket. The strip shall be secured with Class 2 adhesive and stapled. Staples and seams shall be sealed with a brush coat of vapor retarder coating.
- e. Breaks and ribs or standing seam penetrations in the jacket material shall be covered with a patch of the same material as the jacket. Patches shall extend not less than 50 mm beyond the break or penetration and shall be secured with Class 2 adhesive and stapled. Staples and joints shall be sealed with a brush coat of vapor retarder coating.
- f. At jacket penetrations such as hangers, thermometers, and damper operating rods, the voids in the insulation shall be filled and the penetrations sealed with a brush coat of vapor retarder coating.
- g. Insulation terminations and pin punctures shall be sealed and flashed with a reinforced vapor retarder coating finish. The coating shall overlap the adjoining insulation and uninsulated surface 50 mm. Pin puncture coatings shall extend 50 mm from the puncture in all directions.
- h. Oval and round ducts, flexible type, shall be insulated with factory Type I jacket insulation with minimum density of 12 kg per cubic meter attached by applying Class 2 adhesive around the entire perimeter of the duct in 150 mm wide stripe on 300 mm centers.



### 3.3.3 Insulation for Warm Air Duct

For warm air ducts above 16 degrees C, ducts and associated equipment shall be insulated to a thickness which is in accordance with Table III. The following shall be insulated:

- a. Supply ducts.
- b. Return air ducts.
- c. Relief air ducts.
- d. Flexible runouts (field insulated).
- e. Plenums.
- f. Duct-mounted coil casings.
- g. Coil-headers and return bends.
- h. Coil casings.
- i. Fresh air intake ducts.
- j. Filter boxes.
- k. Mixing boxes.
- l. Supply fans.

Insulation for rectangular ducts shall be flexible type where concealed, minimum density 12 kg per cubic meter ; and rigid type where exposed, minimum density 48 kg per cubic meter. Insulation on exposed ducts shall be provided with a white, paintable, factory-applied Type II jacket, or finished with Class 1 adhesive finish. Flexible type insulation shall be used for round ducts, minimum density 12 kg per cubic meter with a factory-applied Type II jacket. Insulation on concealed duct shall be provided with a factory-applied Type II jacket. Class 1 adhesive finish where indicated to be used shall be accomplished by applying two coats of Class 1 adhesive with a layer of glass cloth embedded between the coats. The total dry film thickness shall be approximately 2.0 mm). Duct insulation shall be continuous through sleeves and prepared openings. Duct insulation shall terminate at fire dampers and flexible connections.

#### 3.3.3.1 Installation on Concealed Duct

- a. For rectangular, oval and round ducts, insulation shall be attached by applying Class 2 adhesive around the entire perimeter of the duct in 150 mm wide strips on 300 mm centers.
- b. For rectangular and oval ducts 600 mm and larger, insulation shall be secured to the bottom of ducts by the use of mechanical fasteners. Fasteners shall be spaced on 450 mm centers and not more than 450 mm from duct corner.
- c. For rectangular, oval and round ducts, mechanical fasteners shall be provided on sides of duct risers for all duct sizes. Fasteners

shall be spaced on 450 mm centers and not more than 450 mm from duct corners.

- d. The insulation shall be impaled on the mechanical fasteners where used and shall be pressed thoroughly into the adhesive. The insulation shall not be compressed to a thickness less than that specified. Insulation shall be carried over standing seams and trapeze-type hangers.
- e. Self-locking washers shall be installed where mechanical fasteners are used and the pin trimmed and bent over.
- f. Insulation jacket shall overlap not less than 50 mm at joints and the lap shall be secured with Class 2 adhesive under the lap and stapled on 100 mm centers.

#### 3.3.3.2 Installation on Exposed Duct

- a. For rectangular ducts, the rigid insulation shall be secured to the duct by the use of mechanical fasteners on all four sides of the duct, spaced not more than 300 mm apart and not more than 75 mm from the edges of the insulation joints. A minimum of two rows of fasteners shall be provided for each side of duct 300 mm and larger and a minimum of one row for each side of duct less than 300 mm.
- b. Duct insulation with factory-applied jacket shall be formed with minimum jacket seams, and each piece of rigid insulation shall be fastened to the duct using mechanical fasteners. When the height of projection is less than the insulation thickness, insulation shall be brought up to standing seams, reinforcing, and other vertical projections and shall not be carried over the projection. Jacket shall be continuous across seams, reinforcing, and projections. Where the height of projections is greater than the insulation thickness, insulation and jacket shall be carried over the projection.
- c. Insulation shall be impaled on the fasteners; self-locking washers shall be installed and pin excess clipped and bent over.
- d. Joints on jacketed insulation shall be sealed with a 100 mm wide strip of the same material as the jacket. The strip shall be secured with Class 2 adhesive and stapled.
- e. Breaks and penetrations in the jacket material shall be covered with a patch of the same material as the jacket. Patches shall extend not less than 50 mm beyond the break or penetration and shall be secured with Class 2 adhesive and stapled.
- f. Insulation terminations and pin punctures shall be sealed and flashed with a Class 1 adhesive. Two coats of Class 1 adhesive coating shall be applied with glass cloth embedded between coats. The total coating shall have a dry film thickness of approximately 2.0 mm and shall overlap the adjoining insulation and uninsulated surface 50 mm.

- g. Oval and round ducts, flexible type, shall be insulated with factory Type I jacket insulation, minimum density of 12 kg per cubic meter attached by applying Class 2 adhesive around the entire perimeter of the duct in 150 mm wide stripe on 300 mm center. Joints shall be sealed with a 100 mm wide strip of the same material as the jacket. The strip shall be secured with Class 2 adhesive and stapled.

#### 3.3.4 Ducts Handling Air for Dual Purpose

For air handling ducts for dual purpose below and above 16 degrees C, ducts shall be insulated as specified for cold air duct.

#### 3.3.5 Duct Test Holes

After duct systems have been tested, adjusted, and balanced, breaks in the insulation and jacket shall be repaired in accordance with the applicable section of this specification for the type of duct insulation to be repaired.

##### 3.3.5.1 Round Duct

Aluminum jacket with factory applied moisture retarder shall be applied with the joints lapped not less than 75 mm and secured with bands located at circumferential laps and at not more than 300 mm intervals throughout. Horizontal joints shall lap down to shed water and located at 4 or 8 o'clock position. Joints shall be sealed with caulking to prevent moisture penetration. Where jacketing abuts an uninsulated surface, joints shall be sealed with caulking.

##### 3.3.5.2 Fittings

Fittings and other irregular shapes shall be finished as specified for rectangular ducts.

##### 3.3.5.3 Rectangular Ducts

Two coats of weatherproof mastic shall be applied to the entire surface with a layer of glass cloth embedded between coats. Glass cloth overlaps at joints and adjoining surfaces shall be not less than 50 mm. Each coat of weatherproof mastic shall be 2.0 mm minimum thickness. The top of the exterior duct work shall be built up with insulation in such a manner as to ensure a positive drain of any rain water which may appear. The minimum pitch of the built up section shall be in accordance with the recommendation of the manufacturer of the vapor retarder/weatherproof mastic. Care should be taken in the construction of the built up section so that no low areas appear; this shall ensure no "pooling" of water on the vapor retarder which leads to premature degradation of the retarder and subsequent deterioration of the insulation.

#### 3.4 EQUIPMENT INSULATION INSTALLATION

##### 3.4.1 General

Removable insulation sections shall be provided to cover parts of equipment which must be opened periodically for maintenance including vessel covers,

fasteners, flanges and accessories. Equipment insulation shall be omitted on the following:

- a. Handholes.
- b. Boiler manholes.
- c. Cleanouts.
- d. ASME stamps.
- e. Manufacturer's nameplates.

#### 3.4.2 Insulation for Cold Equipment

Cold equipment below 16 degrees C: Insulation shall be furnished on equipment handling media below 16 degrees C including the following:

- a. Pumps.
- b. Refrigeration equipment parts that are not factory insulated.
- c. Drip pans under chilled equipment.
- d. Cold water storage tanks.
- e. Duct mounted coils.
- f. Cold and chilled water pumps.
- g. Air handling equipment parts that are not factory insulated.
- h. Expansion and air separation tanks.
- i. Fan coil unit casings shall be externally insulated if the factory insulation does not meet or exceed insulation requirement for cold or hot equipment herein. If fan coil unit insulation meets specification insulation requirement and is still condensing water, provide additional casing insulation to stop the condition.
- i. Fan coil unit main and auxiliary drain pans shall be insulated at the factory to meet or exceed insulation requirements for cold equipment given herein. If drain pans sweat or condense after installation and operation and the pan insulation meets specification insulation levels, provide additional flexible cellular foam insulation to stop the condensation.

##### 3.4.2.1 Insulation Type

Insulation shall be suitable for the temperature encountered. Thicknesses shall be as follows:

- a. Equipment Handling Media Between 2 and 16 degrees C: 50 mm thick cellular glass, 38 mm thick flexible cellular, or 25 mm thick phenolic foam.

- b. Equipment Handling Media Between minus 18 degrees C and plus 1 degrees C: 90 mm thick cellular glass, 63.5 mm flexible cellular, or 38 mm thick phenolic foam.
- c. Equipment Handling Media Between minus 34 degrees C and minus 18 degrees C: 100 mm thick cellular glass 75 mm thick flexible cellular, or 38 mm thick phenolic foam.

#### 3.4.2.2 Pump Insulation

- a. Pumps shall be insulated by forming a box around the pump housing. The box shall be constructed by forming the bottom and sides using joints which do not leave raw ends of insulation exposed. Joints between sides and between sides and bottom shall be joined by adhesive with lap strips for rigid mineral fiber and contact adhesive for flexible cellular insulation. The box shall conform to the requirements of MICA-01 plate No. 49 when using flexible cellular insulation. Joints between top cover and sides shall fit tightly forming a female shiplap joint on the side pieces and a male joint on the top cover, thus making the top cover removable.
- b. Exposed insulation corners shall be protected with corner angles.
- c. Upon completion of installation of the insulation, including removable sections, two coats of vapor retarder coating shall be applied with a layer of glass cloth embedded between the coats. The total dry thickness of the finish shall be 2.0 mm. A parting line shall be provided between the box and the removable sections allowing the removable sections to be removed without disturbing the insulation coating. Caulking shall be applied to parting line, between equipment and removable section insulation, and at all penetrations.

#### 3.4.2.3 Other Equipment

- a. Insulation shall be formed or fabricated to fit the equipment. To ensure a tight fit on round equipment, edges shall be beveled and joints shall be tightly butted and staggered.
- b. Insulation shall be secured in place with bands or wires at intervals as recommended by the manufacturer but not more than 300 mm centers except flexible cellular which shall be adhered. Insulation corners shall be protected under wires and bands with suitable corner angles.
- c. Cellular glass and phenolic foam insulation shall be set in a coating of bedding compound, and joints shall be sealed with bedding compound as recommended by the manufacturer. Mineral fiber insulation joints shall be filled with finishing cement.
- d. Insulation on heads of heat exchangers shall be removable. Removable section joints shall be fabricated using a male-female shiplap type joint. The entire surface of the removable section shall be finished by applying two coats of vapor retarder coating with a layer of glass cloth embedded between the coats. The total dry thickness of the finish shall be 2.0 mm.

- e. Exposed insulation corners shall be protected with corner angles.
- f. Insulation on equipment with ribs shall be applied over 150 x 150 mm by 12 gauge welded wire fabric which has been cinched in place, or if approved by the Contracting Officer, spot welded to the equipment over the ribs. Insulation shall be secured to the fabric with J-hooks and 50 x 50 mm washers or shall be securely banded or wired in place on 300 mm centers.

#### 3.4.2.4 Vapor Retarder

Upon completion of installation of insulation, penetrations shall be caulked. Two coats of vapor retarder coating shall be applied over insulation, including removable sections, with a layer of glass cloth embedded between the coats. The total dry thickness of the finish shall be 2.0 mm. Caulking shall be applied to parting line between equipment and removable section insulation.

#### 3.4.3 Insulation for Hot Equipment

Hot equipment above 16 degrees C: Insulation shall be furnished on equipment handling media above 16 degrees C including the following:

- a. Heat exchangers.
- b. Hot water generators.
- c. Water heaters.
- d. Not used
- e. Pumps handling media above 54 degrees C.
- f. Hot water storage tanks.
- g. Air separation tanks.
- h. Unjacketed boilers or parts of boilers.
- i. Boiler flue gas connection from boiler to stack.

##### 3.4.3.1 Insulation

Insulation shall be suitable for the temperature encountered. Shell and tube-type heat exchangers shall be insulated for the temperature of the shell medium. Insulation thicknesses shall be as follows:

- a. Equipment handling steam to 103.4 kPa or other media to 121 degrees C: 50 mm thick rigid mineral fiber, 50 mm thick flexible mineral fiber, 50 mm thick calcium silicate, 38 mm cellular glass, 38 mm thick phenolic foam, to 93.3 degrees C, 25 mm Flexible Cellular.
- b. Equipment handling steam to 1379.0 kPa or other media to 204 degrees C: 75 mm thick rigid mineral fiber, 75 mm thick flexible mineral fiber, 75 mm thick calcium silicate, 75 mm thick cellular glass.

- c. Equipment handling media to 316 degrees C : 127 mm thick rigid mineral fiber, 150 mm thick flexible mineral fiber, 150 mm thick calcium silicate, 150 mm thick cellular glass.

#### 3.4.3.2 Insulation of Pumps

Pumps shall be insulated by forming a box around the pump housing. The box shall be constructed by forming the bottom and sides using joints which do not leave raw ends of insulation exposed. Bottom and sides shall be banded to form a rigid housing which does not rest on the pump. Joints between top cover and sides shall fit tightly. The top cover shall have a joint forming a female shiplap joint on the side pieces and a male joint on the top cover, thus making the top cover removable. Two coats of Class I adhesive shall be applied over insulation, including removable sections, with a layer of glass cloth embedded between the coats. A parting line shall be provided between the box and the removable sections allowing the removable sections to be removed without disturbing the insulation coating. The total dry thickness of the finish shall be 2.0 mm. Caulking shall be applied to parting line of the removable sections and penetrations.

#### 3.4.3.3 Other Equipment

- a. Insulation shall be formed or fabricated to fit the equipment. To ensure a tight fit on round equipment, edges shall be beveled and joints shall be tightly butted and staggered.
- b. Insulation shall be secured in place with bands or wires at intervals as recommended by the manufacturer but not greater than 300 mm centers except flexible cellular which shall be adhered. Insulation corners shall be protected under wires and bands with suitable corner angles.
- c. On high vibration equipment, cellular glass insulation shall be set in a coating of bedding compound as recommended by the manufacturer, and joints shall be sealed with bedding compound. Mineral fiber joints shall be filled with finishing cement.
- d. Insulation on heads of heat exchangers shall be removable. The removable section joint shall be fabricated using a male-female shiplap type joint. Entire surface of the removable section shall be finished as specified.
- e. Exposed insulation corners shall be protected with corner angles.
- f. On equipment with ribs such as boiler flue gas connection, draft fans, insulation shall be applied over 150 x 150 mm by 12 gauge welded wire fabric which has been cinched in place, or if approved by the Contracting Officer, spot welded to the equipment over the ribs. Insulation shall be secured to the fabric with J-hooks and 50 x 50 mm washers or shall be securely banded or wired in place on 300 mm (maximum) centers.
- g. On equipment handling media above 316 degrees C, insulation shall be applied in two or more layers with joints staggered.

- h. Upon completion of installation of insulation, penetrations shall be caulked. Two coats of Class I adhesive shall be applied over insulation, including removable sections, with a layer of glass cloth embedded between the coats. The total dry thickness of the finish shall be 2.0 mm. Caulking shall be applied to parting line between equipment and removable section insulation.

#### 3.4.4 Equipment Exposed to Weather

##### 3.4.4.1 Installation

Equipment exposed to weather shall be insulated and finished in accordance with the requirements for ducts exposed to weather in paragraph DUCT INSULATION INSTALLATION.

##### 3.4.4.2 Optional Panels

At the option of the Contractor, prefabricated metal insulation panels may be used in lieu of the insulation and finish previously specified. Thermal performance shall be equal to or better than that specified for field applied insulation. Panels shall be the standard catalog product of a manufacturer of metal insulation panels. Fastenings, flashing, and support system shall conform to published recommendations of the manufacturer for weatherproof installation that shall prevent moisture from entering the insulation. Panels shall be designed to accommodate thermal expansion and to support a 1112 N walking load without permanent deformation or permanent damage to the insulation. Exterior metal cover sheet shall be aluminum and exposed fastenings shall be stainless steel or aluminum.



Table I - Cold Piping Insulation Thickness  
Pipe Size (mm)

Type of Service	Material	Runouts up to 51 mm*	25 mm & less	32 - 51 mm	64 - 102 mm	127 - 152 mm	203 mm & larger
Refrigerant suction piping	CG		38	38	38	38	38
	FC		25	25	25	25	25
	PF		25	25	25	25	25
Chilled water supply & return	CG	38	38	38	51	51	51
	FC	13	25	25	25	25	25
	PF	13	25	25	25	25	25
Cold domestic water, above and below ceilings	CG	38	38	38	38	38	38
	FC	10	10	10	10	10	10
	PF	10	10	10	10	10	10
Exposed lavatory drains exposed domestic water piping & drains to areas for handicap personnel	FC	13	13	13	13	19	19
	MF	13	25	25	38	38	38
Air conditioning condensate drain located inside building	FC		10	13	13	N/A	N/A
	PF		10	10	10	N/A	N/A

\*When runouts to terminal units exceed 3.66 m the entire length of runout shall be insulated like the main feed pipe.

## LEGEND:

PF - Phenolic Foam  
 CG - Cellular Glass  
 CS - Calcium Silicate  
 MF - Mineral Fiber  
 FC - Flexible Cellular

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Table II - Hot Piping Insulation Thickness  
Pipe Size (mm)

Type of Service (degrees C)	Material	Runouts up to 51 mm	25 mm & less	32 - 51 mm	64 - 102 mm	127 - 203mm 152 mm	& larger
Hot domestic water supply & recirculating system (93.3 C max)	CG	38	38	38	38	38	38
	FC	13	25	25	38	38	38
	PF	13	25	25	25	25	25
	MF	13	25	25	38	38	38
Heating hot water, supply & return (121.1 C max)	CG	38	38	51	51	51	64
	PF	13	25	25	25	25	38
	MF	13	38	38	51	64	76
	CS	25	38	51	64	64	64]

\*When runouts to terminal units exceed 3.66 m, the entire length of runout shall be insulated like the main feed pipe.

Table III - Minimum Duct Insulation (mm)

Cold Air Ducts	50
Relief Ducts	38
Fresh Air Intake Ducts	38
Warm Air Ducts	50
Relief Ducts	38
Fresh Air Intake Ducts	38

## SECTION 15330

## WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 47	(1990) Ferritic Malleable Iron Castings
ASTM A 53	(1995a) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 135	(1993) Electric-Resistance-Welded Steel Pipe
ASTM A 183	(1983; R 1990) Carbon Steel Tract Bolts and Nuts
ASTM A 536	(1984; R 1993) Ductile Iron Castings
ASTM A 795	(1995) Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use
ASTM B 88	(1995a) Seamless Copper Water Tube

## AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.1	(1989) Cast Iron Pipe Flanges and Flanged Fittings
ASME B16.3	(1992) Malleable Iron Threaded Fittings
ASME B16.4	(1992) Cast Iron Threaded Fittings
ASME B16.9	(1993) Factory-Made Wrought Steel Buttwelding Fittings
ASME B16.11	(1991) Forged Fittings, Socket-Welding and Threaded
ASME B16.18	(1984; R 1994) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(1992) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(1995) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

ASME B18.2.1 (1981; Supple 1991; R 1992) Square and Hex Bolts and Screws (Inch Series)

ASME B18.2.2 (1987; R 1993) Square and Hex Nuts (Inch Series)

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1015 (1993) Double Check Backflow Prevention Assembly

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA-10062JU (1992) Standard Methods for the Examination of Water and Wastewater

AWWA B300 (1992) Hypochlorites

AWWA B301 (1992) Liquid Chlorine

AWWA C104 (1990) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water

AWWA C110 (1993) Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (75 mm through 1200 mm), for Water and Other Liquids

AWWA C111 (1990) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

AWWA C151 (1991) Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids

AWWA C203 (1991) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied

AWWA M20 (1973) Manual: Water Chlorination Principles and Practices

FACTORY MUTUAL ENGINEERING AND RESEARCH (FM)

FM P7825 (1995; Supple I; Supple II; Supple III) Approval Guide

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-71 (1990) Cast Iron Swing Check Valves, Flanges and Threaded Ends

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 13 (1996) Installation of Sprinkler Systems

NFPA 24 (1995) Installation of Private Fire Service Mains and Their Appurtenances

NFPA 1963

(1993) Fire Hose Connections

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES  
(NICET)

NICET 1014

(1995) Program Detail Manual for  
Certification in the Field of Fire Protection  
Engineering Technology (Field Code 003)  
Automatic Sprinkler System Layout

UNDERWRITERS LABORATORIES (UL)

UL-01

(1996) Building Materials Directory

UL-04

(1996; Supple) Fire Protection Equipment  
Directory

## 1.2 GENERAL REQUIREMENTS

Wet pipe sprinkler system shall be provided in all areas of the building. The sprinkler system shall provide fire sprinkler protection for the entire area. Except as modified herein, the system shall be designed and installed in accordance with NFPA 13. Pipe sizes which are not indicated on drawings shall be determined by hydraulic calculation.

### 1.2.1 Hydraulic Design

The system shall be hydraulically designed. The minimum pipe size for branch lines in gridded systems shall be 32 mm. Hydraulic calculations shall be in accordance with the Area/Density Method of NFPA 13.

#### 1.2.1.1 Hose Demand

An allowance for exterior hose streams shall be added to the sprinkler system demand at the point of connection to the existing system.

#### 1.2.1.2 Basis for Calculations

The design of the system shall be based upon a water supply with a static pressure of 413 kPa, and a flow of 63 l/s at a residual pressure of 390 kPa. Water supply shall be presumed available at the point of connection to existing. Hydraulic calculations shall be based upon the Hazen-Williams formula with a "C" value of 120 for steel piping, 150 for copper tubing, 140 for new cement-lined ductile-iron piping, and 100 for existing underground piping.

### 1.2.2 Sprinkler Spacing

Sprinklers shall be uniformly spaced on branch lines. Maximum spacing per sprinkler shall not exceed limits specified in NFPA 13.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. Submittals related to system configuration, hydraulic calculations, and equipment

selection, including manufacturer's catalog data, working drawings, connection drawings, control diagrams and certificates shall be submitted concurrently as a complete package. The package will be reviewed by the U.S. Army Engineer District Fire Protection Engineer. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

#### SD-01 Data

##### Load Calculations for Sizing Sway Bracing

For systems that are required to be protected against damage from earthquakes, load calculations shall be provided for sizing of sway bracing.

Sprinkler System Equipment; GA.

Manufacturer's Catalog Data for each separate piece of equipment proposed for use in the system. Data shall indicate the name of the manufacturer of each item of equipment, with data highlighted to indicate model, size, options, etc. proposed for installation. In addition, a complete equipment list which includes equipment description, model number and quantity shall be provided.

Hydraulic Calculations; GA.

Hydraulic calculations, including a drawing showing hydraulic reference points and pipe segments.

Spare Parts; FIO.

Spare parts data shall be included for each different item of material and equipment specified. The data shall include a complete list of parts and supplies, with current unit prices and source of supply, and a list of parts recommended by the manufacturer to be replaced after 1 year and 3 years of service. A list of special tools and test equipment required for maintenance and testing of the products supplied by the Contractor shall be included.

#### SD-04 Drawings

Sprinkler System Shop Drawings; GA.

Detail drawings conforming to the requirements established for working plans as prescribed in NFPA 13. Drawings shall include plan and elevation views which establish that the equipment will fit the allotted spaces with clearance for installation and maintenance. Each set of drawings shall include the following:

- a. Descriptive index of drawings in the submittal with drawings listed in sequence by drawing number. A legend identifying device symbols, nomenclature, and conventions used.
- b. Floor plans drawn to a scale not less than 1:100 which clearly show locations of sprinklers, risers, pipe hangers, seismic separation assemblies, sway bracing, inspector's test connections, drains, and other applicable details necessary to clearly describe the proposed arrangement. Each type of fitting used and the locations of bushings, reducing couplings, and welded joints shall be indicated.

- c. Actual center-to-center dimensions between sprinklers on branch lines and between branch lines; from end sprinklers to adjacent walls; from walls to branch lines; from sprinkler feed mains, cross-mains and branch lines to finished floor and roof or ceiling. A detail shall show the dimension from the sprinkler and sprinkler deflector to the ceiling in finished areas.
- d. Longitudinal and transverse building sections showing typical branch line and cross-main pipe routing as well as elevation of each typical sprinkler above finished floor.
- e. Details of each type of riser assembly; pipe hanger; sway bracing for earthquake protection, and restraint of underground water main at point-of-entry into the building, and electrical devices and interconnecting wiring.

As-Built Drawings; GA.

As-built drawings, no later than 14 working days after completion of the Final Tests. The sprinkler system shop drawings shall be updated to reflect as-built conditions after work is completed and shall be on reproducible full-size mylar film.

#### SD-06 Instructions

Test Procedures; GA.

Proposed test procedures for piping hydrostatic test, testing of alarms, at least 14 days prior to the start of related testing.

#### SD-07 Schedules

Preliminary Tests; GA.

A schedule of preliminary tests, at least 14 days prior to the proposed start of the tests.

Final Test; GA.

Upon successful completion of tests specified under PRELIMINARY TESTS, written notification shall be given to the Contracting Officer of the date for the final acceptance test. Notification shall be provided at least 14 days prior to the proposed start of the test. Notification shall include a copy of the Contractor's Material & Test Certificates.

#### SD-08 Statements

Installer Qualifications; GA.

Qualifications of the sprinkler installer.

Submittal Preparer's Qualifications; GA.

The name and documentation of certification of the individual who will prepare the submittals, prior to the submittal of the drawings and hydraulic calculations.



### SD-13 Certificates

Contractor's Material & Test Certificates; FIO.

Certificates, as specified in NFPA 13, shall be completed and signed by the Contractor's Representative performing required tests for both underground and aboveground piping.

### SD-19 Operation and Maintenance Manuals

Sprinkler System; GA.

Manuals shall be in loose-leaf binder format and grouped by technical sections consisting of manufacturer's standard brochures, schematics, printed instructions, general operating procedures, and safety precautions. The manuals shall list routine maintenance procedures possible breakdowns, and repairs, and troubleshooting guide. This shall include procedures and instructions pertaining to frequency of preventive maintenance, inspection, adjustment, lubrication and cleaning necessary to minimize corrective maintenance and repair.

## 1.4 HYDRAULIC CALCULATIONS

Hydraulic calculations shall be as outlined in NFPA 13 except that calculations shall be performed by computer using software specifically designed for fire protection system design. Software which uses k-factors for typical branch lines is not acceptable. Calculations shall be taken back to the water supply source unless water supply data is otherwise indicated. Calculations shall substantiate that the design area indicated is the hydraulically most demanding. Water supply curves and system requirements shall be plotted on semi-logarithmic graph paper so as to present a summary of the complete hydraulic calculation. A summary sheet listing sprinklers in the design area and their respective hydraulic reference points, elevations, actual discharge pressures and actual flows shall be provided. Elevations of hydraulic reference points (nodes) shall be indicated. Documentation shall identify each pipe individually and the nodes connected thereto. The diameter, length, flow, velocity, friction loss, number and type fittings, total friction loss in the pipe, equivalent pipe length and Hazen-Williams coefficient shall be indicated for each pipe. For gridded systems, calculations shall show peaking of demand area friction loss to verify that the hydraulically most demanding area is being used. Also for gridded systems, a flow diagram indicating the quantity and direction of flows shall be included. A drawing showing hydraulic reference points (nodes) and pipe designations used in the calculations shall be included and shall be independent of shop drawings.

## 1.5 SUBMITTAL PREPARER'S QUALIFICATIONS

The sprinkler system submittals, including as-built drawings, shall be prepared by an individual who is either a registered professional engineer or who is certified as a Level III Technician by National Institute for Certification in Engineering Technologies (NICET) in the Automatic Sprinkler System Layout subfield of Fire Protection Engineering Technology in accordance with NICET 1014.

## 1.6 INSTALLER QUALIFICATIONS

The installer shall be experienced and regularly engaged in the installation of the type and complexity of system included in this project. A statement prior to submittal of any other data or drawings, that the proposed sprinkler system installer is regularly engaged in the installation of the type and complexity of system included in this project shall be provided. In addition, data identifying the location of at least three systems recently installed by the proposed installer which are comparable to the system specified shall be submitted. Contractor shall certify that each system has performed satisfactorily, in the manner intended, for a period of not less than 6 months.

## 1.7 REGULATORY REQUIREMENTS

Compliance with referenced NFPA standards is mandatory. This includes advisory provisions listed in the appendices of such standards, as though the word "shall" had been substituted for the word "should" wherever it appears. Applicable material and installation standards referenced in Appendix A of NFPA 13 and NFPA 24 shall be considered mandatory the same as if such referenced standards were specifically listed in this specification. In the event of a conflict between specific provisions of this specification and applicable NFPA standards, this specification shall govern. All requirements that exceed the minimum requirements of NFPA 13 shall be incorporated into the design. Reference to "authority having jurisdiction" shall be interpreted to mean the Contracting Officer.

## 1.8 DELIVERY AND STORAGE

Equipment placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust or other contaminants.

## 2 PRODUCTS

### 2.1 GENERAL EQUIPMENT REQUIREMENTS

#### 2.1.1 Standard Products

Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

#### 2.1.2 Requirements for Fire Protection Service

Equipment and materials shall have been tested by Underwriters Laboratories, Inc. and listed in UL-04 or approved by Factory Mutual and listed in FM P7825. Where the terms "listed" or "approved" appear in this specification, such shall mean listed in UL-04 or FM P7825.

#### 2.1.3 Nameplates

Major components of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate permanently affixed to the item of equipment.

## 2.2 UNDERGROUND PIPING SYSTEMS

### 2.2.1 Pipe

Piping from a point 150 mm above the floor to a point 1500 mm outside the building wall shall be ductile iron with a rated working pressure of 2067 kPa conforming to AWWA C151, with cement mortar lining conforming to AWWA C104. Piping more than 1500 mm outside the building walls shall comply with Section 02660.

### 2.2.2 Fittings and Gaskets

Fittings shall be ductile iron conforming to AWWA C110. Gaskets shall be suitable in design and size for the pipe with which such gaskets are to be used. Gaskets for ductile iron pipe joints shall conform to AWWA C111.

### 2.2.3 Gate Valve and Indicator Posts

Gate valves for underground installation shall be of the inside screw type with counter-clockwise rotation to open. Where indicating type valves are shown or required, indicating valves shall be gate valves with an approved indicator post of a length to permit the top of the post to be located 900 mm above finished grade. Gate valves and indicator posts shall be listed in UL-04 or FM P7825.

## 2.3 ABOVEGROUND PIPING SYSTEMS

Aboveground piping shall be steel or copper.

### 2.3.1 Steel Piping System

#### 2.3.1.1 Steel Pipe

Except as modified herein, steel pipe shall be black as permitted by NFPA 13 and shall conform to applicable provisions of ASTM A 795, ASTM A 53, or ASTM A 135. Pipe in which threads or grooves are cut shall be Schedule 40 or shall be listed by Underwriters' Laboratories to have a corrosion resistance ratio (CRR) of 1.0 or greater after threads or grooves are cut. Pipe shall be marked with the name of the manufacturer, kind of pipe, and ASTM designation.

#### 2.3.1.2 Fittings for Non-Grooved Steel Pipe

Fittings shall be cast iron conforming to ASME B16.4, steel conforming to ASME B16.9 or ASME B16.11, or malleable iron conforming to ASME B16.3. Fittings into which sprinklers, drop nipples or riser nipples (sprigs) are screwed shall be threaded type. Plain-end fittings with mechanical couplings, fittings which use steel gripping devices to bite into the pipe and segmented welded fittings shall not be used.

#### 2.3.1.3 Grooved Mechanical Joints and Fittings

Joints and fittings shall be designed for not less than 1200 kPa service and shall be the product of the same manufacturer. Fitting and coupling houses shall be malleable iron conforming to ASTM A 47, Grade 32510; ductile iron conforming to ASTM A 536, Grade 65-45-12. Gasket shall be the flush type that fills the entire cavity between the fitting and the pipe. Nuts

and bolts shall be heat-treated steel conforming to ASTM A 183 and shall be cadmium plated or zinc electroplated.

#### 2.3.1.4 Flanges

Flanges shall conform to NFPA 13 and ASME B16.1. Gaskets shall be non-asbestos compressed material in accordance with ASME B16.21, 1.6 mm thick, and full face or self-centering flat ring type. Bolts shall be squarehead conforming to ASME B18.2.1 and nuts shall be hexagon type conforming to ASME B18.2.2.

#### 2.3.2 Copper Tube Systems

##### 2.3.2.1 Copper Tube

Copper tube shall conform to ASTM B 88, Types L and M.

##### 2.3.2.2 Copper Fittings

Cast copper alloy pressure fittings shall conform to ASME B16.18 and wrought copper and bronze pressure fittings shall conform to ASME B16.22.

#### 2.3.3 Pipe Hangers

Hangers shall be listed in UL-04 or FM P7825 and of the type suitable for the application, construction, and pipe type and sized involved.

#### 2.3.4 Valves

##### 2.3.4.1 Control Valve and Gate Valve

Manually operated sprinkler control valve and gate valve shall be outside stem and yoke (OS&Y) type and shall be listed in UL-01 or FM P7825.

##### 2.3.4.2 Check Valve

Check valve 50 mm and larger shall be listed in UL-01 or FM P7825. Check valves 100 mm and larger shall be of the swing type with flanged cast iron body and flanged inspection plates, shall have a clear waterway and shall meet the requirements of MSS SP-71, for Type 3 or 4.

#### 2.4 ALARM CHECK VALVE ASSEMBLY

Assembly shall include an alarm check valve, standard trim piping, pressure gauges, bypass, retarding chamber, testing valves, main drain, and other components as required for a fully operational system.

#### 2.5 WATER MOTOR ALARM ASSEMBLY

Assembly shall include a body housing, impeller or pelton wheel, drive shaft, striker assembly, gong, wall plate and related components necessary for complete operation. Minimum 20 mm galvanized piping shall be provided between the housing and the alarm check valve. Drain piping from the body housing shall be minimum 25 mm galvanized and shall be arranged to drain to the outside of the building. Piping shall be galvanized both on the inside and outside surfaces.

## 2.6 ALARM INITIATING AND SUPERVISORY DEVICES

### 2.6.1 Sprinkler Waterflow Indicator Switch, Vane Type

Switch shall be vane type with a pipe saddle and cast aluminum housing. The electro-mechanical device shall include a flexible, low-density polyethylene paddle conforming to the inside diameter of the fire protection pipe. The device shall sense water movements and be capable of detecting a sustained flow of 38 L/min or greater. The device shall contain a retard device adjustable from 0 to 90 seconds to reduce the possibility of false alarms caused by transient flow surges. The switch shall include two SPDT (Form C) contacts, and shall be equipped with a silicone rubber gasket to assure positive water seal and a dustproof cover and gasket to seal the mechanism from dirt and moisture.

### 2.6.2 Sprinkler Pressure (Waterflow) Alarm Switch

Pressure switch shall include a metal housing with a neoprene diaphragm, SPDT snap action switches and a 15 mm NPT male pipe thread. The switch shall have a maximum service pressure rating of 1207 kPa. There shall be two SPDT (Form C) contacts factory adjusted to operate at 28 to 55 kPa. The switch shall be capable of being mounted in any position in the alarm line trim piping of the alarm check valve.

### 2.6.3 Valve Supervisory (Tamper) Switch

Switch shall be suitable for mounting to the type of control valve to be supervised open. The switch shall be tamper resistant and contain one set of SPDT (Form C) contacts arranged to transfer upon removal of the housing cover or closure of the valve of more than two rotations of the valve stem.

## 2.7 FIRE DEPARTMENT CONNECTION

Fire department connection shall be projecting type with cast brass body, matching wall escutcheon lettered "Auto Spkr" with a polished brass finish. The connection shall have two inlets with individual self-closing clappers, caps with drip drains and chains. Female inlets shall have 65 mm diameter American National Fire Hose Connection Screw Threads (NH) per NFPA 1963.

## 2.8 SPRINKLERS

Sprinklers shall be used in accordance with their listed spacing limitations. Temperature classification shall be in accordance with NFPA 13.

### 2.8.1 Upright Sprinkler

Upright sprinkler shall be brass quick-response type and shall have a nominal 12.7 mm or 13.5 mm orifice.

### 2.8.2 Pendent Sprinkler

Pendent sprinkler shall be of the fusible strut or glass bulb type, semi-recessed quick-response type with nominal 12.7 mm orifice. Pendent sprinklers shall have a polished chrome finish.

### 2.8.3 Sidewall Sprinkler

Sidewall sprinkler shall have a nominal 12.7 mm orifice. Sidewall sprinkler shall have a polished chrome finish. Sidewall sprinkler shall be the quick-response type.

### 2.8.4 Dry Sprinkler Assembly

Dry sprinkler assembly shall be of the pendent type. Assembly shall include an integral escutcheon. Maximum length shall not exceed maximum indicated in UL-04. Sprinklers shall have a polished chrome finish.

## 2.9 DISINFECTING MATERIALS

### 2.9.1 Liquid Chlorine

Liquid chlorine shall conform to AWWA B301.

### 2.9.2 Hypochlorites

Calcium hypochlorite and sodium hypochlorite shall conform to AWWA B300.

## 2.10 ACCESSORIES

### 2.10.1 Sprinkler Cabinet

Spare sprinklers shall be provided in accordance with NFPA 13 and shall be packed in a suitable metal or plastic cabinet. Spare sprinklers shall be representative of, and in proportion to, the number of each type and temperature rating of the sprinklers installed. At least one wrench of each type required shall be provided.

### 2.10.2 Pendent Sprinkler Escutcheon

Escutcheon shall be one-piece metallic type with a depth of less than 20 mm and suitable for installation on pendent sprinklers. The escutcheon shall have a factory finish that matches the pendent sprinkler heads.

### 2.10.3 Pipe Escutcheon

Escutcheon shall be polished chromium-plated zinc alloy, or polished chromium-plated copper alloy. Escutcheons shall be either one-piece or split-pattern, held in place by internal spring tension or set screw.

### 2.10.4 Sprinkler Guard

Guard shall be a steel wire cage designed to encase the sprinkler and protect it from mechanical damage. Guards shall be provided on sprinklers located in the mechanical room.

### 2.10.5 Identification Sign

Valve identification sign shall be minimum 150 mm wide x 50 mm high with enamel baked finish on minimum 1.214 mm steel or 0.6 mm aluminum with red letters on a white background or white letters on red background. Wording of sign shall include, but not be limited to "main drain," "auxiliary

drain," "inspector's test," "alarm test," "alarm line," and similar wording as required to identify operational components.

## 2.11 DOUBLE-CHECK VALVE BACKFLOW PREVENTION ASSEMBLY

Double-check backflow prevention assembly shall comply with ASSE 1015. The assembly shall have a bronze, cast-iron or stainless steel body with flanged ends. The assembly shall include OS&Y shutoff valves on the inlet and outlet, 2-positive-seating check valve for continuous pressure application, and four test cocks. Assemblies shall be rated for working pressure of 1034 kPa. The maximum pressure loss shall be 40 kPa at a flow rate equal to the sprinkler water demand, at the location of the assembly.

## 3 EXECUTION

### 3.1 INSTALLATION REQUIREMENTS

The installation shall be in accordance with the applicable provisions of NFPA 13, NFPA 24 and publications referenced therein.

### 3.2 ABOVEGROUND PIPING INSTALLATION

Piping shall be run straight and bear evenly on hangers and supports.

#### 3.2.1 Protection of Piping Against Earthquake Damage

The system piping shall be protected against damage from earthquakes. Seismic protection of the piping system shall be provided in accordance with NFPA 13 and Appendix A, with the exception that the "Earthquake Zones" map of Appendix A shall not apply to this project. Seismic protection shall include flexible couplings, sway bracing, seismic separation assemblies where piping crosses building seismic separation joints, and other features as required in NFPA 13 for protection of piping against damage from earthquakes. Branch lines shall be equipped with sway braces at the end sprinkler head and at intervals not exceeding 9 m where required by NFPA 13.

#### 3.2.2 Piping in Exposed Areas

Exposed piping shall be installed so as not to diminish exit access widths, corridors or equipment access. Exposed horizontal piping, including drain piping, shall be installed to provide maximum headroom.

#### 3.2.3 Piping in Finished Areas

In areas with suspended or dropped ceilings and in areas with concealed spaces above the ceiling, piping shall be concealed above ceilings. Piping shall be inspected, tested and approved before being concealed. Risers and similar vertical runs of piping in finished areas shall be concealed.

#### 3.2.4 Pendent Sprinklers

Drop nipples to pendent sprinklers shall consist of minimum 25 mm pipe with a reducing coupling into which the sprinkler shall be threaded. Hangers shall be provided on arm-overs to drop nipples supplying pendent sprinklers when the arm-over exceeds 300 mm. Where sprinklers are installed below suspended or dropped ceilings, drop nipples shall be cut such that sprinkler ceiling plates or escutcheons are of a uniform depth throughout the finished

space. The outlet of the reducing coupling shall not extend more than 25 mm below the underside of the ceiling. On pendent sprinklers installed below suspended or dropped ceilings, the distance from the sprinkler deflector to the underside of the ceiling shall not exceed 100 mm. Recessed pendent sprinklers shall be installed such that the distance from the sprinkler deflector to the underside of the ceiling shall not exceed the manufacturer's listed range and shall be of uniform depth throughout the finished area.

#### 3.2.4.1 Pendent Sprinkler Locations

Pendent sprinklers in suspended ceilings shall be a minimum of 150 mm from ceiling grid.

#### 3.2.5 Upright Sprinklers

Riser nipples or "sprigs" to upright sprinklers shall contain no fittings between the branch line tee and the reducing coupling at the sprinkler. Riser nipples exceeding 750 mm in length shall be individually supported.

#### 3.2.6 Pipe Joints

Pipe joints shall conform to NFPA 13, except as modified herein. Not more than four threads shall show after joint is made up. Welded joints will be permitted, only if welding operations are performed as required by NFPA 13 at the Contractor's fabrication shop, not at the project construction site. Flanged joints shall be provided where indicated or required by NFPA 13. Grooved pipe and fittings shall be prepared in accordance with the manufacturer's latest published specification according to pipe material, wall thickness and size. Grooved couplings and fittings shall be from the same manufacturer.

#### 3.2.7 Reducers

Reductions in pipe sizes shall be made with one-piece tapered reducing fittings. The use of grooved-end or rubber-gasketed reducing couplings will not be permitted. When standard fittings of the required size are not manufactured, single bushings of the face type will be permitted. Where used, face bushings shall be installed with the outer face flush with the face of the fitting opening being reduced. Bushings shall not be used in elbow fittings, in more than one outlet of a tee, in more than two outlets of a cross, or where the reduction in size is less than 15 mm.

#### 3.2.8 Pipe Penetrations

Cutting structural members for passage of pipes or for pipe-hanger fastenings will not be permitted. Pipes that must penetrate concrete or masonry walls or concrete floors shall be core-drilled and provided with pipe sleeves. Each sleeve shall be Schedule 40 galvanized steel, ductile iron or cast iron pipe and shall extend through its respective wall or floor and be cut flush with each wall surface. Sleeves shall provide required clearance between the pipe and the sleeve per NFPA 13. The space between the sleeve and the pipe shall be firmly packed with mineral wool insulation. Where pipes pass through fire walls, fire partitions, or floors, a fire seal shall be placed between the pipe and sleeve in accordance with Section 07270 FIRESTOPPING. In penetrations which are not fire-rated or not a floor penetration, the space between the sleeve and the pipe shall be sealed at



both ends with plastic waterproof cement which will dry to a firm but pliable mass or with a mechanically adjustable segmented elastomer seal.

#### 3.2.9 Escutcheons

Escutcheons shall be provided for pipe penetration of ceilings and walls. Escutcheons shall be securely fastened to the pipe at surfaces through which piping passes.

#### 3.2.10 Inspector's Test Connection

Unless otherwise indicated, test connection shall consist of 25 mm pipe connected to the remote branch line; a test valve located approximately 2 meters above the floor; a smooth bore brass outlet equivalent to the smallest orifice sprinkler used in the system; and a painted metal identification sign affixed to the valve with the words "Inspector's Test." The discharge orifice shall be located outside the building wall directed so as not to cause damage to adjacent construction or landscaping during full flow discharge.

#### 3.2.11 Drains

Main drain piping shall be provided to discharge at a safe point outside the building. Auxiliary drains shall be provided as required by NFPA 13 except that drain valves shall be used where drain plugs are otherwise permitted. Where branch lines terminate at low points and form trapped sections, such branch lines shall be manifolded to a common drain line.

#### 3.2.12 Installation of Fire Department Connection

Connection shall be mounted on the exterior wall approximately 900 mm above finished grade. The piping between the connection and the check valve shall be provided with an automatic drip in accordance with NFPA 13 and arranged to drain to the outside.

#### 3.2.13 Identification Signs

Signs shall be affixed to each control valve, inspector test valve, main drain, auxiliary drain, test valve, and similar valves as appropriate or as required by NFPA 13. Hydraulic design data nameplates shall be permanently affixed to each sprinkler riser as specified in NFPA 13.

### 3.3 UNDERGROUND PIPING INSTALLATION

The fire protection water main shall be laid, and joints anchored, in accordance with NFPA 24. Minimum depth of cover shall be 1000 mm. The supply line shall terminate inside the building with a flanged piece, the bottom of which shall be set not less than 150 mm above the finished floor. A blind flange shall be installed temporarily on top of the flanged piece to prevent the entrance of foreign matter into the supply line. A concrete thrust block shall be provided at the elbow where the pipe turns up toward the floor. In addition, joints shall be anchored in accordance with NFPA 24 using pipe clamps and steel rods from the elbow to the flange above the floor and from the elbow to a pipe clamp in the horizontal run of pipe. Buried steel components shall be provided with a corrosion protective coating in accordance with AWWA C203. Piping more than 1500 mm outside the building walls shall meet the requirements of Section 02660.

### 3.4 EARTHWORK

Earthwork shall be performed in accordance with applicable provisions of Section 02221.

### 3.5 ELECTRICAL WORK

Alarm signal wiring connected to the building fire alarm control system shall be in accordance with Section 16721.

### 3.6 STERILIZATION

After system components have been installed and pressure tested, each portion of the completed system shall be sterilized. After pressure tests have been made, the portion to be sterilized shall be thoroughly flushed with water until all entrained dirt and other foreign materials have been removed before introducing chlorinating material. The chlorinating material shall be hypochlorites or liquid chlorine. Water chlorination procedure shall be in accordance with AWWA M20. The chlorinating material shall be fed into the sprinkler piping at a constant rate of 50 parts per million (ppm). A properly adjusted hypochlorite solution injected into the system with a hypochlorinator, or liquid chlorine injected into the system through a solution-fed chlorinator and booster pump, shall be used. Chlorination application shall continue until the entire system is filled. The water shall remain in the system for a minimum of 24 hours. Each valve in the system shall be opened and closed several times to ensure its proper disinfection. Following the 24-hour period, no less than 25 ppm chlorine residual shall remain in the system. The system shall be then flushed with clean water until the residual chlorine is reduced to less than one part per million. Samples of water in properly sterilized containers for bacterial examination will be taken from several system locations which are approved by the Contracting Officer. Samples shall be tested for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with AWWA-10062JU. The testing method shall be either the multiple-tube fermentation technique or the membrane-filter technique. The sterilization shall be repeated until tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in the samples for at least 2 full days. The system will not be accepted until satisfactory bacteriological results have been obtained.

### 3.7 FIELD PAINTING AND FINISHING

Field painting and finishing are specified in Section 09900.

### 3.8 PRELIMINARY TESTS

The system, including the underground water mains, and the aboveground piping and system components, shall be tested to assure that equipment and components function as intended. The underground and aboveground interior piping systems and attached appurtenances subjected to system working pressure shall be tested in accordance with NFPA 13 and NFPA 24. Upon completion of specified tests, the Contractor shall complete certificates as specified in paragraph SUBMITTALS.

### 3.8.1 Underground Piping

#### 3.8.1.1 Flushing

Underground piping shall be flushed in accordance with NFPA 24. This includes the requirement to flush the lead-in connection to the fire protection system at a flow rate not less than the calculated maximum water demand rate of the system.

#### 3.8.1.2 Hydrostatic Testing

New underground piping shall be hydrostatically tested in accordance with NFPA 24. The allowable leakage shall be measured at the specified test pressure by pumping from a calibrated container. The amount of leakage at the joints shall not exceed 1.89 liters per hour per 100 gaskets or joints, regardless of pipe diameter.

### 3.8.2 Aboveground Piping

#### 3.8.2.1 Hydrostatic Testing

Aboveground piping shall be hydrostatically tested in accordance with NFPA 13 at not less than 1400 kPa or 350 kPa in excess of maximum system operating pressure and shall maintain that pressure without loss for 2 hours. There shall be no drop in gauge pressure or visible leakage when the system is subjected to the hydrostatic test. The test pressure shall be read from a gauge located at the low elevation point of the system or portion being tested.

### 3.8.3 Testing of Alarm Devices

Each alarm switch shall be tested by flowing water through the inspector's test connection. Each water-operated alarm devices shall be tested to verify proper operation.

### 3.8.4 Main Drain Flow Test

Following flushing of the underground piping, a main drain test shall be made to verify the adequacy of the water supply. Static and residual pressures shall be recorded on the certificate specified in paragraph SUBMITTALS. In addition, a main drain test shall be conducted each time after a main control valve is shut and opened.

## 3.9 FINAL ACCEPTANCE TEST

A technician employed by the installing Contractor shall be present for the final tests and shall provide a complete demonstration of the operation of the system. This shall include operation of control valves and flowing of inspector's test connections to verify operation of associated waterflow alarm switches. After operation of control valves has been completed, the main drain test shall be repeated to assure that control valves are in the open position. In addition, the representative shall have available copies of as-built drawings and certificates of tests previously conducted. The installation shall not be considered accepted until identified discrepancies have been corrected and test documentation is properly completed and received.

## SECTION 15331

## MANUAL DRY STANDPIPE SYSTEM, FIRE PROTECTION

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 47	(1990) Ferritic Malleable Iron Castings
ASTM A 53	(1995a) Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless
ASTM A 135	(1993) Electric-Resistance-Welded Steel Pipe
ASTM A 183	(1983; R 1990) Carbon Steel Track Bolts and Nuts
ASTM A 536	(1984; R 1993) Ductile Iron Castings
ASTM A 795	(1995) Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use

## AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.1	(1989) Cast Iron Pipe Flanges and Flanged Fittings
ASME B16.3	(1992) Malleable Iron Threaded Fittings
ASME B16.4	(1992) Cast Iron Threaded Fittings
ASME B16.9	(1993) Factory-Made Wrought Steel Buttwelding Fittings
ASME B16.11	(1991) Forged Fittings, Socket-Welding and Threaded
ASME B16.21	(1992) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B18.2.1	(1981; Supple 1991; R 1992) Square and Hex Bolts and Screws (Inch Series)
ASME B18.2.2	(1987; R 1993) Square and Hex Nuts (Inch Series)

## AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C104	(1990) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C110	(1993) Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (75 mm through 1200 mm), for Water and Other Liquids
AWWA C111	(1990) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C151	(1991) Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids
AWWA C203	(1991) Coal-tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied.

## FACTORY MUTUAL ENGINEERING AND RESEARCH (FM)

FM P7825	(1994; Supple I; Supple II; Supple III) Approval Guide
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## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 13	(1994) Installation of Sprinkler Systems
NFPA 24	(1995) Installation of Private Fire Service Mains and Their Appurtenances
NFPA 1963	(1993) Fire Hose Connections

## NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES (NICET)

NICET 1014	(1995) Program Detail Manual for Certification in the Field of Fire Protection Engineering Technology (Field Code 003) Automatic Sprinkler System Layout
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## UNDERWRITERS LABORATORIES (UL)

UL-04	(1996; Supple) Fire Protection Equipment Directory
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## 1.2 GENERAL REQUIREMENTS

Manual dry standpipe system shall be provided for each barracks building. Except as modified herein, the system shall meet the requirements of NFPA 14. Pipe sizes which are not indicated on the drawings shall be determined by hydraulic calculation.

## 1.2.1 Hydraulic Design

Hydraulic calculations shall be provided in accordance with the Minimum Flow Rate Method of NFPA 14, Chapter 5.

#### 1.2.1.1 Hose Demand

A minimum flow rate for exterior hose streams of 500 gpm shall be provided for the system at the hydraulically most remote standpipe. The minimum flow rate for additional standpipes shall be 250 gpm per standpipe, with a total not to exceed 1,250 gpm.

#### 1.2.1.2 Basis for Calculations

The design of the system shall be based upon a water supply with a static pressure of 413 kPa, and a flow of 63 l/s at a residual pressure of 390 kPa. Water supply shall be presumed available at the nearest hydrant. System pressure shall be presumed available at the pumper fire apparatus. Hydraulic calculations shall be based upon the Hazen-Williams formula with a "C" value of 120 for galvanized steel piping, 140 for new cement-lined ductile-iron piping, and 100 for existing underground piping.

### 1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. Submittals related to system configuration, hydraulic calculations, and equipment selection, including manufacturer's catalog data, working drawings, connection drawings, control diagrams and certificates shall be submitted concurrently as a complete package. The package will be reviewed by the U.S. Army Engineer District Fire Protection Engineer. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

#### SD-01 Data

Fire Protection System Equipment; GA.

Manufacturer's Catalog Data for each separate piece of equipment proposed for use in the system. Data shall indicate the name of the manufacturer of each item of equipment, with data highlighted to indicate model, size, options, etc. proposed for installation. In addition, a complete equipment list which includes equipment description, model number and quantity shall be provided.

Hydraulic Calculations; GA.

Hydraulic calculations, including a drawing showing hydraulic reference points and pipe segments.

Spare Parts; FIO.

Spare parts data for each different item of material and equipment specified. The data shall include a complete list of parts and supplies, with current unit prices and source of supply, and a list of parts recommended by the manufacturer to be replaced after 1 year and 3 years of service. A list of special tools and test equipment required for maintenance and testing of the products supplied by the Contractor shall be included.

## SD-04 Drawings

## Fire Protection System Shop Drawings; FIO.

Detailed drawings conforming to the requirements established for working plans as prescribed in NFPA 14. Drawings shall include plan and elevation views which establish that the equipment will fit the allotted spaces with clearance for installation and maintenance. Each set of drawings shall include the following:

a. Descriptive index of drawings in the submittal with drawings listed in sequence by drawing number. A legend identifying device symbols, nomenclature, and conventions used.

b. Floor plans drawn to a scale not less than  $1/8" = 1'-0"$  which clearly show locations of risers, pipe hangers, seismic separation assemblies, sway bracing, drains, and other applicable details necessary to clearly describe the proposed arrangement. Each type of fitting used and the locations of bushings, reducing couplings, and welded joints shall be indicated.

c. Details of each type of riser assembly; pipe hanger; sway bracing for earthquake protection; restraint of underground water main at point-of-entry into the building; and electrical devices and interconnecting wiring.

## As-Built Drawings; FIO.

As-built drawings, no later than 14 working days after completion of the Final Tests. The fire protection system shop drawings shall be updated to reflect as-built conditions after work is completed and shall be submitted on reproducible full-size mylar film.

## SD-09 Reports

## Final Test; GA.

Upon successful completion of tests specified in PRELIMINARY TESTS, written notification shall be given to the Contracting Officer of the date for the final acceptance test. Notification shall be provided at least 14 days prior to the proposed start of the final test. Notification shall include a copy of the Contractor's Material Test Certificates.

## SD-08 Statements

## Installer Qualifications; GA.

Qualifications of the fire protection system installer.

## Submittal Preparer's Qualifications; FIO.

The name and documentation of certification of the individual who will prepare the submittals, prior to the submittal of the drawings and hydraulic calculations.

## SD-13 Certificates

## Contractor's Material Test Certificates; GA.

Certificates, as specified in NFPA 13, shall be completed and signed by the Contractor's Representative performing required tests for both underground and aboveground piping.

#### 1.4 HYDRAULIC CALCULATIONS

Hydraulic calculations shall be as outlined in NFPA 14. Calculations shall be taken back to the water supply source or to the point where flow test data was measured. Water supply curves and system requirements shall be plotted on semi-logarithmic graph paper so as to present a summary of the complete hydraulic calculations. A summary sheet listing hose connections in the design area and their respective hydraulic reference points, elevations, actual discharge pressures and actual flows shall be provided. Elevations of hydraulic reference points (nodes) shall be indicated. Documentation shall identify each pipe individually and the nodes connected thereto. The diameter, length, flow, velocity, friction loss, number and type fittings, total friction loss in the pipe, equivalent pipe length and Hazen-Williams coefficient shall be indicated for each pipe. A drawing showing hydraulic reference points (nodes) and pipe designations used in the calculations shall be included and shall be independent of shop drawings.

#### 1.5 SUBMITTAL PREPARER'S QUALIFICATIONS

The standpipe and hose connections system submittals, including as-built drawings, shall be prepared by an individual who is either a registered professional engineer or who is certified as a Level III technician by National Institute for Certification in Engineering Technologies (NICET) in the Automatic Sprinkler System Layout subfield of Fire Protection Engineering Technology in accordance with NICET 1014.

#### 1.6 INSTALLER QUALIFICATIONS

The installer shall be experienced and regularly engaged in the installation of the type and complexity of system included in this project. A statement prior to submittal of any other data or drawings, that the proposed system installer is regularly engaged in the installation of the type and complexity of system included in this project shall be provided. In addition, data identifying the location of at least 3 systems recently installed by the proposed installer which are comparable to the system specified shall be submitted. Contractor shall certify that each system has performed satisfactorily, in the manner intended, for a period of not less than 6 months.

#### 1.7 REGULATORY REQUIREMENTS

Compliance with referenced NFPA standards is mandatory. This includes advisory provisions listed in the appendices of such standards, as though the word "shall" had been substituted for the word "should" wherever it appears. Applicable material and installation standards referenced in Appendices A and B of NFPA 14 and NFPA 24 shall be considered mandatory the same as if such referenced standards were specifically listed in this specification. In the event of a conflict between specific provisions of this specification and applicable NFPA standards, this specification shall govern. All requirements that exceed the minimum requirements of NFPA 14 shall be incorporated into the design. Reference to "authority having jurisdiction" shall be interpreted to mean the Contracting Officer.



## 1.8 DELIVERY AND STORAGE

Equipment placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust or other contaminants.

## 2 PRODUCTS

### 2.1 GENERAL EQUIPMENT REQUIREMENTS

#### 2.1.1 Standard Products

Material and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

#### 2.1.2 Requirements for Fire Protection Service

Unless otherwise specified, equipment and materials shall have been tested by Underwriters Laboratories, Inc. and listed in UL-04 or approved by Factory Mutual and listed in FM P7825. Where the terms "listed" or "approved" appear in this specification, such shall mean listed in UL-04 or FM P7825.

#### 2.1.3 Nameplates

Major components of equipment shall have the manufacturer's name, address, type or style, model or serial number, voltage and current rating and catalog number on a metal plate permanently affixed to the equipment.

### 2.2 UNDERGROUND PIPING SYSTEMS

#### 2.2.1 Pipe

Piping from a point 150 mm above the floor to 1500 mm outside the building wall the point of connection to the existing water mains shall be ductile iron with a rated working pressure of 2067 kPa conforming to AWWA C151, with cement mortar lining conforming to AWWA C104. Piping more than 1500 mm outside the building walls shall comply with Section 02660.

#### 2.2.2 Fittings and Gaskets

Fittings shall be ductile iron conforming to AWWA C110. Gaskets shall be suitable in design and size for the pipe with which such gaskets are to be used. Gaskets for ductile iron pipe joints shall conform to AWWA C111.

### 2.3 ABOVEGROUND PIPING SYSTEMS

#### 2.3.1 Piping Systems

Piping shall be steel galvanized piping. The inside wall and the exterior of the pipe shall be galvanized. Steel piping shall be Schedule 40 for sizes less than 200 mm in diameter and Schedule 30 or 40 for sizes 200 mm and larger in diameter. Piping shall conform to applicable provisions of ASTM A 795, ASTM A 53, or ASTM A 135. Pipe in which threads or grooves are

cut shall be Schedule 40. Pipe shall be marked with the name of the manufacturer, kind of pipe, and ASTM designation.

#### 2.3.2 Fittings For Non-Grooved Piping

Fittings shall be cast iron conforming to ASME B16.4, galvanized steel conforming to ASME B16.9 or ASME B16.11, or malleable iron conforming to ASME B16.3. Plain-end fittings with mechanical couplings, fittings which use steel gripping devices to bite into the pipe and segmented welded fittings shall not be used.

#### 2.3.3 Grooved Mechanical Joints and Fittings

Joints and fittings shall be designed for not less than 2067 kPa service and shall be the product of the same manufacturer. Fitting and coupling houses shall be malleable iron conforming to ASTM A 47, Grade 32510; ductile iron conforming to ASTM A 536, Grade 65-45-12. Gaskets shall be of silicon compound and approved for dry fire protection systems. Gasket shall be the flush type that fills the entire cavity between the fitting and the pipe. Nuts and bolts shall be heat-treated steel conforming to ASTM A 183 and shall be cadmium plated or zinc electroplated.

#### 2.3.4 Flanges

Flanges shall conform to NFPA 13 and ASME B16.1. Gaskets shall be non-asbestos compressed material in accordance with ASME B16.21, 1/16 inch thick, and full face or self-centering flat ring type. Bolts shall be square-head conforming to ASME B18.2.1 and nuts shall be hexagon type conforming to ASME B18.2.2.

#### 2.3.5 Pipe Hangers

Hangers shall be listed in UL-04 or FM P7825 and be of the type suitable for the application, construction, and size pipe involved.

### 2.4 FIRE DEPARTMENT CONNECTION

Fire department connection shall be yard, protecting type with cast brass body, a polished brass finish. Size of threaded connections shall be in accordance with Ft. Sill Fire Department requirements and NFPA 14. The connection shall have two inlets, caps with drip drains and chains. Female inlets shall be American National Fire Hose Connection Screw Threads (NH) per NFPA 1963.

### 2.5 ACCESSORIES

#### 2.5.1 IDENTIFICATION SIGN

Identification signs shall be minimum 6 inches wide x 2 inches high with enamel baked finish on minimum 18 gauge steel or 0.024 inch aluminum with red letters on a white background or white letters on red background. Wording of sign shall include, but not be limited to "main drain," "auxiliary drain," "inspector's test," "alarm test," "alarm line," "hose connection," "standpipe", and similar wording as required to identify operational components.

### 2.5.2 Hose Valve

Valve shall comply with UL 668 and shall have a minimum rating of 2067 kPa. Valve shall be non-rising stem, all bronze, with American National Standard Fire Hose Screw Thread (NH) male outlet in accordance with NFPA 1963. Hose valve shall be provided with 65 mm to 40 mm reducer. Hose valves shall be equipped with lugged cap with drip drain, cap gasket and chain. Valve finish shall be polished brass.

## 3 EXECUTION

### 3.1 INSTALLATION REQUIREMENTS

The installation shall be in accordance with the applicable provisions of NFPA 14, NFPA 24 and publications referenced therein.

### 3.2 ABOVEGROUND PIPING INSTALLATION

Piping shall be run straight and bear evenly on hangers and supports.

#### 3.2.1 Protection of Piping Against Earthquake Damage

The system piping shall be protected against damage from earthquakes. Seismic protection of the piping system shall be provided in accordance with NFPA 13 and Appendix A, with the exception that the "Earthquake Zones" map of Appendix A shall not apply to this project. Seismic protection shall include flexible couplings, sway bracing, seismic separation assemblies where piping crosses building seismic separation joints, and other features as required in NFPA 14 for protection of piping against damage from earthquakes.

#### 3.2.2 Piping in Exposed Areas

Exposed piping shall be installed so as not diminish exit access widths, corridors or equipment access. Exposed horizontal piping, including drain piping, shall be installed to provide maximum headroom.

#### 3.2.3 Pipe Joints

Pipe joints shall conform to NFPA 14, except as modified herein. Not more than four threads shall show after joint is made up. Welded joints will be permitted, only if welding operations are performed as required by NFPA 13 at the Contractor's fabrication shop, not at the project construction site. Flanged joints shall be provided where indicated or required by NFPA 14. Grooved pipe and fittings shall be prepared in accordance with the manufacturer's latest published specification according to pipe material, wall thickness and size. Grooved couplings and fittings shall be from the same manufacturer.

#### 3.2.4 Reducers

Reductions in pipe sizes shall be made with one-piece tapered reducing fittings. The use of grooved end or rubber-gasket reducing couplings will not be permitted. When standard fittings of the required size are not manufactured, single bushings of the face type will be permitted. Where used, face bushings shall be installed with the outer face flush with the face of the fitting opening being reduced. Bushings shall not be used in

elbow fittings, in more than one outlet of a tee, in more than two outlets of a cross, or where the reduction in size is less than 1/2 inch.

### 3.2.5 Pipe Penetrations

Cutting structural members for passage of pipes or for pipe-hanger fastenings will not be permitted. Pipes that must penetrate concrete or masonry walls or concrete floors shall be core-drilled and provided with pipe sleeves. Each sleeve shall be Schedule 40 galvanized steel, ductile iron or cast iron pipe and shall extend through its respective wall or floor and be cut flush with each wall surface. Sleeves shall provide required clearance between the pipe and sleeve per NFPA 13. The space between the sleeve and the pipe shall be firmly packed with mineral wool insulation. Where pipes pass through fire walls, fire partitions, or floors, a fire seal shall be placed between the pipe and sleeve in accordance with Section 07270. In penetrations which are not fire-rated or not a floor penetration, the space between the sleeve and the pipe shall be sealed at both ends with plastic waterproof cement which will dry to a firm but pliable mass or with a mechanically adjustable segmented elastomer seal.

### 3.2.6 Escutcheons

Escutcheons shall be provided for pipe penetrations of ceilings and walls. Escutcheons shall be securely fastened to the pipe at surfaces through which piping passes.

### 3.2.7 Drains

A main drain shall be provided in a valve box located near the fire department connection. The drain shall be a 40 mm hose valve. The installation shall allow easy connection of a 40 mm hose.

### 3.2.8 Installation of Fire Department Connection

The fire department connection shall be located as indicated on contract drawing M002.

### 3.2.9 Identification Signs

The fire department connection shall be identified in accordance with NFPA 14.

## 3.3 UNDERGROUND PIPING INSTALLATION

The underground piping shall be laid, and joints anchored, in accordance with NFPA 24. Minimum depth of cover shall be 1000 mm. A concrete thrust block shall be provided at the elbow where the pipe turns up toward the floor. In addition, joints shall be anchored in accordance with NFPA 24 using pipe clamps and steel rods from the elbow to the flange above the floor and from the elbow to a pipe clamp in the horizontal run of pipe. Buried steel components shall be provided with a corrosion protective coating in accordance with AWWA C203. Piping more than 1500 mm outside the building walls shall meet the requirements of Section 02660.

### 3.4 EARTHWORK

Earthwork shall be performed in accordance with applicable provisions of Section 02222.

### 3.5 FIELD PAINTING AND FINISHING

Field painting and finishing are specified in Section 09900.

### 3.6 PRELIMINARY TESTS

The system, including the underground water mains, and the aboveground piping and system components, shall be tested to assure that equipment and components function as intended. Upon completion of specified tests, the Contractor shall complete certificates as specified in paragraph SUBMITTALS.

#### 3.6.1 Underground Piping

##### 3.6.1.1 Flushing

Underground piping shall be flushed in accordance with NFPA 24. This includes the requirement to flush the lead-in connection to the fire protection system at a flow rate not less than the calculated maximum water demand rate of the system.

##### 3.6.1.2 Hydrostatic Testing

New underground piping shall be hydrostatically tested in accordance with NFPA 24. The allowable leakage shall be measured at the specified test pressure by pumping from a calibrated container. The amount of leakage at the joints shall not exceed 2 liters per hour per 100 gaskets or joints, regardless of pipe diameter.

#### 3.6.2 Aboveground Piping

##### 3.6.2.1 Hydrostatic Testing

Aboveground piping shall be hydrostatically tested in accordance with NFPA 14 at not less than 1378 kPa and shall maintain that pressure without loss for 2 hours. There shall be no drop in gauge pressure or visible leakage when the system is subjected to the hydrostatic test. The test pressure shall be read from a gauge located at the low elevation point of the system or portion being tested.

### 3.7 FINAL TEST

#### 3.7.1 Acceptance

The technician shall have available copies of as-built drawings and certificates of tests previously conducted. The installation will not be considered accepted until identified discrepancies have been corrected, test documentation is properly completed and received, and the system has been verified to be void of water.

## SECTION 15400

## PLUMBING, GENERAL PURPOSE

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ARI 1010 (1994) Drinking-Fountains and Self-Contained, Mechanically-Refrigerated Drinking-Water Coolers

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI SAMA Z236.1 (1983) General Purpose Lab for Liquid-in-Glass Thermometers - General Purpose Laboratory Use

ANSI Z21.10.1 (1993) Gas Water Heaters Vol. I Storage Water Heaters with Input Ratings of 75,000 Btu Per Hour or Less

ANSI Z21.10.3 (1993; Z21.10.3) Gas Water Heaters Vol. III Storage, with Input Ratings Above 75,000 Btu Per Hour, Circulating and Instantaneous Water Heaters

ANSI Z21.22 (1986; Z21.22a) Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems

ANSI Z21.56 (1991; Z21.56a; Z21.56b) Gas-Fired Pool Heaters

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 47 (1990) Ferritic Malleable Iron Castings

ASTM A 53 (1993a) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

ASTM A 74 (1994) Cast Iron Soil Pipe and Fittings

ASTM A 105 (1994) Forgings, Carbon Steel, for Piping Components

ASTM A 183 (1983; R 1990) Carbon Steel Track Bolts and Nuts

ASTM A 193 (1994b) Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service

ASTM A 515 (1992) Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service

ASTM A 516 (1990) Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service

ASTM A 518 (1992) Corrosion-Resistant High-Silicon Iron Castings

ASTM A 536 (1984; R 1993) Ductile Iron Castings

ASTM A 733	(1993) Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM A 888	(1994) Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
ASTM B 32	(1993) Solder Metal
ASTM B 42	(1993) Seamless Copper Pipe, Standard Sizes
ASTM B 43	(1991) Seamless Red Brass Pipe, Standard Sizes
ASTM B 75	(1993) Seamless Copper Tube
ASTM B 88	(1993a) Seamless Copper Water Tube
ASTM B 117	(1994) Operating Salt Spray (Fog) Testing Apparatus
ASTM B 152	(1993a) Copper Sheet, Strip, Plate, and Rolled Bar
ASTM B 306	(1992) Copper Drainage Tube (DWV)
ASTM B 370	(1992) Copper Sheet and Strip for Building Construction
ASTM B 584	(1993b) Copper Alloy Sand Castings for General Applications
ASTM B 641	(1993) Seamless and Welded Copper Distribution Tube (Type D)
ASTM B 813	(1993) Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube
ASTM C 564	(1993) Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C 920	(1987) Elastomeric Joint Sealants
ASTM C 1053	(1990) Borosilicate Glass Pipe and Fittings for Drain, Waste, and Vent (DWV) Applications
ASTM D 638	(1994b) Tensile Properties of Plastics
ASTM D 1004	(1994a) Initial Tear Resistance of Plastic Film and Sheet
ASTM D 1248	(1984; R 1989) Polyethylene Plastics Molding and Extrusion Materials
ASTM D 2000	(1990) Rubber Products in Automotive Applications
ASTM D 2485	(1991) Evaluating Coatings for High Temperature Service
ASTM D 2822	(1991) Asphalt Roof Cement
ASTM D 3308	(1991a) PTFE Resin Skived Tape
ASTM D 4060	(1990) Abrasion Resistance of Organic Coatings by the Taber Abraser

ASTM D 4101 (1992b) Propylene Plastic Injection and Extrusion Materials

ASTM E 96 (1994) Water Vapor Transmission of Materials

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 (1989; 90.1b; 90.1c; 90.1d; 90.1e; 90.1g; 90.1i) Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A112.1.2 (1991) Air Gaps in Plumbing Systems

ASME A112.6.1M (1988) Supports for Off-the-Floor Plumbing Fixtures for Public Use

ASME A112.14.1 (1975; R 1990) Backwater Valves

ASME A112.18.1M (1994; Errata Feb 1995) Plumbing Fixture Fittings

ASME A112.19.2M (1990) Vitreous China Plumbing Fixtures

ASME A112.21.1M (1991) Floor Drains

ASME A112.21.2M (1983) Roof Drains

ASME A112.36.2M (1991) Cleanouts

ASME B1.20.1 (1983; R 1992) Pipe Threads, General Purpose (Inch)

ASME B16.3 (1992) Malleable Iron Threaded Fittings

ASME B16.4 (1992) Cast Iron Threaded Fittings

ASME B16.5 (1988; Errata Oct 88; B16.5a) Pipe Flanges and Flanged Fittings

ASME B16.12 (1991) Cast Iron Threaded Drainage Fittings

ASME B16.15 (1985) Cast Bronze Threaded Fittings Classes 125 and 250

ASME B16.18 (1984) Cast Copper Alloy Solder Joint Pressure Fittings

ASME B16.21 (1992) Nonmetallic Flat Gaskets for Pipe Flanges

ASME B16.22 (1989) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

ASME B16.23 (1992; Errata Jan 1994) Cast Copper Alloy Solder Joint Drainage Fittings - DWV

ASME B16.24 (1991; Errata Jun 91) Cast Copper Alloy Pipe Flanges, Class 150, 300, 400, 600, 900, 1500 and 2500, and Flanged Fittings, Class 150 and 300



ASME B16.29	(1986) Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV
ASME B16.39	(1986) Malleable Iron Threaded Pipe Unions Classes 150, 250, and 300
ASME B31.1	(1992; B31.1a; B31.1b; B31.1c) Power Piping
ASME B31.5	(1992; B31.5a) Refrigeration Piping
ASME B40.1	(1991) Gauges - Pressure Indicating Dial Type - Elastic Element
ASME BPV VIII Div 1	(1992; Addenda Dec 1992, Dec 1993, Dec 1994) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage
ASME BPV IX	(1992; Addenda Dec 1992, Dec 1993, Dec 1994) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications
ASME CSD-1	(1992; CSD-1a; CSD-1b) Controls and Safety Devices for Automatically Fired Boilers

## AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1001	(1990) Pipe Applied Atmospheric Type Vacuum Breakers
ASSE 1002	(1992) Water Closet Flush Tank Ball Locks
ASSE 1003	(1981) Water Pressure Reducing Valves for Domestic Water Supply Systems
ASSE 1005	(1993) Water Heater Drain Valves - 3/4-Inch Iron Pipe Size
ASSE 1006	(1986) Residential Use (Household) Dishwashers
ASSE 1011	(1993) Hose Connection Vacuum Breakers
ASSE 1012	(1993) Backflow Preventers with Intermediate Atmospheric Vent
ASSE 1013	(1993) Reduced Pressure Principle Backflow Preventers
ASSE 1018	(1986) Trap Seal Primer Valves Water Supply Fed
ASSE 1037	(1990) Pressurized Flushing Devices (Flushometers) for Plumbing Fixtures/F

## AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA-01	(1992) Standard Methods for the Examination of Water and Wastewater
AWWA B300	(1992) Hypochlorites
AWWA B301	(1992) Liquid Chlorine
AWWA C105	(1988) Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids

AWWA C203	(1991) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C606	(1987) Grooved and Shouldered Joints
AWWA C700	(1990; C700a) Cold-water Meters - Displacement Type, Bronze Main Case
AWWA M20	(1973) Manual: Water Chlorination Principles and Practices

## AMERICAN WELDING SOCIETY (AWS)

AWS A5.8	(1992) Filler Metals for Brazing and Braze Welding
AWS B2.2	(1991) Brazing Procedure and Performance Qualification

## CAST IRON SOIL PIPE INSTITUTE (CISPI)

CISPI 301	(1990) Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
CISPI HSN	(1985) Neoprene Rubber Gaskets for Hub and Spigot Cast Iron Soil Pipe and Fittings

## CODE OF FEDERAL REGULATIONS (CFR)

10 CFR 430	Energy Conservation Program for Consumer Products
21 CFR 175	Indirect Food Additives: Adhesives and Components of Coatings

## COMMERCIAL ITEM DESCRIPTIONS (CID)

CID A-A-238	(Rev B) Seat, Water Closet
CID A-A-240	(Basic) Shower Head, Ball Joint
CID A-A-50012	(Basic) Garbage Disposal Machine, Commercial

## COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA 404/O-RR	(1992) Copper Tube for Plumbing, Heating, Air Conditioning and Refrigeration
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## COUNCIL OF AMERICAN BUILDING OFFICIALS (CABO)

CABO A117.1	(1992; Errata Jun 1993) American National Standard for Accessible and Usable buildings and Facilities
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## FEDERAL SPECIFICATIONS (FS)

FS OO-D-431	(Rev E) Dishwashing Machines, Commercial (Rack, Stationary)
FS QQ-B-654	(Rev A; Am 1; Notice 1) Brazing Alloys, Silver
FS TT-P-1536	(Rev A) Plumbing Fixture Setting Compound
FS WW-C-440	(Rev B; Am 2) Clamps, Hose, (Low-Pressure)

FS WW-P-541/GEN	(Rev E; Am 1) Plumbing Fixtures
FS WW-P-541/3	(Rev B; Am 1) Plumbing Fixtures (Bathtubs)
FS WW-P-541/4	(Rev B; Am 1) Plumbing Fixtures (Lavatories)
FS WW-P-541/5	(Rev B; Am 1) Plumbing Fixtures (Sinks, Kitchen, Service, and Laundry Trays)
FS WW-P-541/9	(Rev B; Am 1) Plumbing Fixtures (Medical Facilities, Land Use)
FS WW-U-516	(Rev B; Notice 1) Unions, Brass or Bronze, Threaded Pipe Connections and Solder-Joint Tube Connections
FS WW-V-35	(Rev C) Valve, Ball
FOUNDATION FOR CROSS-CONNECTION CONTROL AND HYDRAULIC RESEARCH (FCCHR)	
FCCHR-01	(1993) Manual of Cross-Connection Control
HYDRAULIC INSTITUTE (HI)	
HI-01	(1983) Standards for Centrifugal, Rotary Reciprocating Pumps
MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)	
MSS SP-25	(1993) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-44	(1991) Steel Pipe Line Flanges
MSS SP-58	(1993) Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-67	(1990) Butterfly Valves
MSS SP-69	(1991) Pipe Hangers and Supports - Selection and Application
MSS SP-70	(1990) Cast Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(1990) Cast Iron Swing Check Valves, Flanges and Threaded Ends
MSS SP-72	(1992) Ball Valves with Flanged or Butt-welding Ends for General Service
MSS SP-73	(1991) Brazing Joints for Copper and Copper Alloy Pressure Fittings
MSS SP-78	(1987; R 1992) Cast Iron Plug Valves, Flanged and Threaded Ends
MSS SP-80	(1987) Bronze Gate, Globe, Angle and Check Valves
MSS SP-83	(1987) Steel Pipe Unions Socket-Welding and Threaded

MSS SP-84 (1990) Valves - Socket Welding and Threaded Ends

MSS SP-85 (1994) Cast Iron Globe Angle Valves Flanged and Threaded Ends

NATIONAL ASSOCIATION OF PLUMBING-HEATING-COOLING CONTRACTORS (NAPHCC)

NAPHCC-01 (1993; Supple 1994) National Standard Plumbing Code (Non-Illustrated Edition)

NAPHCC-02 (1993) National Standard Plumbing Code Illustrated Edition

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (1991) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 31 (1992) Installation of Oil Burning Equipment

NFPA 54 (1992) National Fuel Gas Code

NFPA 90A (1993) Installation of Air Conditioning and Ventilating Systems

NSF INTERNATIONAL (NSF)

PLUMBING AND DRAINAGE INSTITUTE (PDI)

PDI G-101 (1985) Testing and Rating Procedures for Grease Interceptors

PDI WH 201 (1992) Water Hammer Arresters

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

SSPC SP 5 (1991) White Metal Blast Cleaning

UNDERWRITERS LABORATORIES (UL)

UL 174 (1989; Rev thru Jan 1991) Household Electric Storage-Tank Water Heaters

UL 430 (1994) Waste Disposers

UL 732 (1988) Oil-Fired Storage Tank Water Heaters

UL 749 (1995) Household Dishwashers

## 1.2 STANDARD PRODUCTS

Specified materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of such products. Specified equipment shall essentially duplicate equipment that has performed satisfactorily at least two years prior to bid opening.

### 1.3 PERFORMANCE REQUIREMENTS

#### 1.3.1 Welding

Piping shall be welded in accordance with qualified procedures using performance-qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPV IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer, may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified 24 hours in advance of tests, and the tests shall be performed at the work site if practicable. Welders or welding operators shall apply their assigned symbols near each weld they make as a permanent record.

#### 1.3.2 Cathodic Protection and Pipe Joint Bonding

Cathodic protection and pipe joint bonding systems shall be in accordance with Section 16640 CATHODIC PROTECTION SYSTEM (IMPRESS CURRENT).

### 1.4 ELECTRICAL WORK

Motors, motor controllers and motor efficiencies shall conform to the requirements of Section 16415 ELECTRICAL WORK, INTERIOR. Electrical motor-driven equipment specified herein shall be provided complete with motors. Equipment shall be rated at 60 Hz, single phase, ac unless otherwise indicated. Where a motor controller is not provided in a motor-control center on the electrical drawings, a motor controller shall be as indicated. Motor controllers shall be provided complete with properly sized thermal-overload protection in each ungrounded conductor, auxiliary contact, and other equipment, at the specified capacity, and including an allowable service factor.

### 1.5 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

SD-01 Data

Welding; FIO.

A copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators.

Vibration-Absorbing Features; FIO.

Details of vibration-absorbing features, including arrangement, foundation plan, dimensions and specifications.

SD-04 Drawings

Plumbing System; FIO.

Detail drawings consisting of illustrations, schedules, performance charts, instructions, brochures, diagrams, and other information to illustrate the requirements and operations of each system. Detail drawings for the complete plumbing system including piping layouts and locations of connections; dimensions for roughing-in, foundation, and support points; schematic diagrams and wiring diagrams or connection and interconnection diagrams. Detail drawings shall indicate clearances required for maintenance and operation. Where piping and equipment are to be supported other than as indicated, details shall include loadings and proposed support methods. Mechanical drawing plans, elevations, views, and details, shall be drawn to scale.

Electrical Schematics; FIO.

Complete electrical schematic lineless or full line interconnection and connection diagram for each piece of mechanical equipment having more than one automatic or manual electrical control device.

#### SD-06 Instructions

Plumbing System; FIO.

Diagrams, instructions, and other sheets proposed for posting. Manufacturer's recommendations for the installation of bell and spigot and hubless joints for cast iron soil pipe.

#### SD-09 Reports

Tests, Flushing and Sterilization; FIO.

Test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, completion and testing of the installed system. Each test report shall indicate the final position of controls.

#### SD-13 Certificates

Materials and Equipment; FIO.

Where materials or equipment are specified to comply with requirements of AGA, or ASME, proof of such compliance. The label or listing of the specified agency will be acceptable evidence. In lieu of the label or listing, a written certificate may be submitted from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency. Where equipment is specified to conform to requirements of the ASME Boiler and Pressure Vessel Code, the design, fabrication, and installation shall conform to the code.

Bolts; FIO.

Written certification by the bolt manufacturer that the bolts furnished comply with the specified requirements. The certification shall include illustrations of product-required markings, the date of manufacture, and the number of each type of bolt to be furnished based on this certification.

## SD-19 Operation and Maintenance Manuals

## Plumbing System; FIO.

Six copies of the operation manual outlining the step-by-step procedures required for system startup, operation and shutdown. The manual shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Six copies of the maintenance manual listing routine maintenance procedures, possible breakdowns and repairs. The manual shall include piping and equipment layout and simplified wiring and control diagrams of the system as installed.

## 1.6 REGULATORY REQUIREMENTS

## 1.6.1 Plumbing

Plumbing work shall be in accordance with NAPHCC-01, unless otherwise stated and installed in accordance with NAPHCC-02.

## 1.7 PROJECT/SITE CONDITIONS

The Contractor shall become familiar with details of the work, verify dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

## PART 2 PRODUCTS

## 2.1 MATERIALS

Materials for various services shall be in accordance with TABLES I and II. Pipe schedules shall be selected based on service requirements. Pipe fittings shall be compatible with the applicable pipe materials. Pipe threads (except dry seal) shall conform to ASME B1.20.1. Grooved pipe couplings and fittings shall be from the same manufacturer. Material or equipment containing lead shall not be used in any potable water system. Hubless cast-iron soil pipe shall not be installed under concrete floor slabs or in crawl spaces below kitchen floors.

## 2.1.1 Pipe Joint Materials

Grooved pipe shall not be used under ground. Joints and gasket materials shall conform to the following:

- a. Coupling for Cast-Iron Pipe: ASTM A 74, AWWA C606.
- b. Couplings for Grooved Pipe: Ductile Iron ASTM A 536 (Grade 65-45-12).
- c. Flange Gaskets: Gaskets shall be made of non-asbestos material in accordance with ASME B16.21. Gaskets shall be flat, 1/16 inch thick, and contain Aramid fibers bonded with Styrene Butadiene Rubber (SBR) or Nitro Butadiene Rubber (NBR). Gaskets shall be the full face or self centering flat ring type. Gaskets used for hydrocarbon service shall be bonded with NBR.
- d. Neoprene Gaskets for Hub and Cast-Iron Pipe and Fittings: CISPI HSN.
- e. Brazing Material: Brazing material shall conform to AWS A5.8, BCuP-5.

f. Brazing Flux: Flux shall be in paste or liquid form appropriate for use with brazing material. Flux shall be as follows: lead-free; have a 100 percent flushable residue; contain slightly acidic reagents; contain potassium borides; and contain fluorides. Silver brazing materials shall be in accordance with FS QQ-B-654.

g. Solder Material: Solder metal shall conform to ASTM B 32 95-5 tin-antimony.

h. Solder Flux: Flux shall be liquid form, non-corrosive, and conform to ASTM B 813, Standard Test 1.

i. PTFE Tape: PTFE Tape, for use with Threaded Metal Pipe, ASTM D 3308.

j. Rubber Gaskets for Cast-Iron Soil-Pipe and Fittings: ASTM C 564.

k. Rubber Gaskets for Grooved Pipe: ASTM D 2000, maximum temperature 230 degrees F.

l. Flexible Elastomeric Seals: ASTM D 3139, ASTM D 3212 or ASTM F 477.

m. Bolts and Nuts for Grooved Pipe Couplings: Heat-treated carbon steel, ASTM A 183.

n. Flanged fittings including flanges, bolts, nuts, bolt patterns, etc. shall be in accordance with ASME B16.5 class 150 and shall have the manufacturer's trademark affixed in accordance with MSS SP-25. Flange material shall conform to ASTM A 105. Blind flange material shall conform to ASTM A 516 cold service and ASTM A 515 for hot service. Bolts shall be high strength or intermediate strength with material conforming to ASTM A 193.

#### 2.1.2 Miscellaneous Materials

Miscellaneous materials shall conform to the following:

a. Water Hammer Arrestor: PDI WH 201.

b. Copper, Sheet and Strip for Building Construction: ASTM B 370.

c. Asphalt Roof Cement: ASTM D 2822.

d. Hose Clamps: FS WW-C-440.

e. Supports for Off-The-Floor Plumbing Fixtures: ASME A112.6.1M.

f. Metallic Cleanouts: ASME A112.36.2M.

g. Plumbing Fixture Setting Compound: FS TT-P-1536, Type II.

h. Coal-Tar Protective Coatings and Linings for Steel Water Pipelines: AWWA C203.

i. Hypochlorites: AWWA B300.

j. Liquid Chlorine: AWWA B301.

k. Polyethylene Encasement for Ductile-Iron Piping: AWWA C105.

l. Gauges - Pressure and Vacuum Indicating Dial Type - Elastic Element: ASME B40.1.



m. Thermometers: ANSI SAMA Z236.1 .

### 2.1.3 Pipe Insulation Material

Insulation shall be as specified in Section 15250 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

## 2.2 PIPE HANGERS, INSERTS, AND SUPPORTS

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69.

## 2.3 VALVES

Valves shall be provided on supplies to equipment and fixtures. Valves 65 mm and smaller shall be bronze with threaded bodies for pipe and solder-type connections for tubing. Valves 80 mm and larger shall have flanged iron bodies and bronze trim. Pressure ratings shall be based upon the application. Grooved end valves may be provided if the manufacturer certifies that the valves meet the performance requirements of applicable MSS standard. Valves shall conform to the following standards:

<u>Description</u>	<u>Standard</u>
Butterfly Valves	MSS SP-67
Cast-Iron Gate Valves, Flanged and Threaded Ends	MSS SP-70
Cast-Iron Swing Check Valves, Flanged and Threaded Ends	MSS SP-71
Ball Valves with Flanged Butt-Welding Ends for General Service	MSS SP-72
Ball Valves	FS WW-V-35
Cast-Iron Plug Valves, Flanged and Threaded Ends	MSS SP-78
Bronze Gate, Globe, Angle, and Check Valves	MSS SP-80
Steel Valves, Socket Welding and Threaded Ends	MSS SP-84
Cast-Iron Globe and Angle Valves, Flanged and Threaded Ends	MSS SP-85
Backwater Valves	ASME A112.14.1
Vacuum Relief Valves	ASSE 1001
Water Pressure Reducing Valves	ASSE 1003
Water Heater Drain Valves	ASSE 1005
Trap Seal Primer Valves	ASSE 1018
Temperature and Pressure Relief Valves	ANSI Z21.22

## for Hot Water Supply Systems

Temperature and Pressure Relief Valves  
for Automatically Fired Hot  
Water Boilers

ASME CSD-1 Safety  
Code No., Part CW,  
Article 5

## 2.3.2 Wall Faucets

Wall faucets with vacuum-breaker backflow preventer shall be brass with 20 mm male inlet threads, hexagon shoulder, and 20 mm hose connection. Faucet handle shall be securely attached to stem.

## 2.3.3 Wall Hydrants

Wall hydrants with vacuum-breaker backflow preventer shall have a nickle-brass or nickel-bronze wall plate or flange with nozzle and detachable key handle. A brass or bronze operating rod shall be provided within a galvanized iron casing of sufficient length to extend through the wall so that the valve is inside the building, and the portion of the hydrant between the outlet and valve is self-draining. A brass or bronze valve with coupling and union elbow having metal-to-metal seat shall be provided. Valve rod and seat washer shall be removable through the face of the hydrant. The hydrant shall have 20 mm exposed hose thread on spout and 20 mm male pipe thread on inlet.

## 2.3.4 Yard Hydrants

Yard box or post hydrants shall have valve housings located below frost lines. Water from the casing shall be drained after valve is shut off. Hydrant shall be bronze with cast-iron box or casing guard. "T" handle key shall be provided.

## 2.3.5 Relief Valves

Water heaters and hot water storage tanks shall have a combination pressure and temperature (PT) relief valve. The pressure relief element of a PT relief valve shall have adequate capacity to prevent excessive pressure buildup in the system when the system is operating at the maximum rate of heat input. The temperature element of a PT relief valve shall have a relieving capacity which is at least equal to the total input of the heaters when operating at their maximum capacity. Relief valves shall be rated according to ANSI Z21.22. Relief valves for systems where the maximum rate of heat input is less than 58.5995 kW shall have 20 mm minimum inlets and outlets. Relief valves for systems where the maximum rate of heat input is greater than 58.5995 kW shall have 25 mm minimum inlets and outlets. The discharge pipe from the relief valve shall be the size of the valve outlet.

## 2.4 FIXTURES

Fixtures shall be water conservation type, in accordance with NAPHCC-01. Fixtures for use by the physically handicapped shall be in accordance with CABO A117.1. Vitreous china, nonabsorbent, hard-burned, and vitrified throughout the body shall be provided. Porcelain enameled ware shall have specially selected, clear white, acid-resisting enamel coating evenly applied on surfaces. No fixture will be accepted that shows cracks, crazes, blisters, thin spots, or other flaws. Fixtures shall be equipped with appurtenances such as traps, faucets, stop valves, and drain fittings. Each fixture and piece of equipment requiring connections to the drainage system, except grease interceptors, shall be equipped with a trap. Brass expansion or toggle bolts capped with acorn nuts shall be provided for supports, and polished chromium plated pipe, valves, and fittings shall be provided where exposed to view. Fixtures with the supply discharge below the rim shall be

equipped with backflow preventers. Internal parts of flush and/or flushometer valves, shower mixing valves, shower head face plates, pop-up stoppers of lavatory waste drains, and pop-up stoppers and overflow tees and shoes of bathtub waste drains may contain acetal resin, fluorocarbon, nylon, acrylonitrile-butadiene-styrene (ABS) or other plastic material, if the material has provided satisfactory service under actual commercial or industrial operating conditions for not less than 2 years. Plastic in contact with hot water shall be suitable for 82.22 degrees C water temperature. Plumbing fixtures shall generally be in accordance with FS WW-P-541/GEN, and shall be as indicated in paragraph PLUMBING FIXTURE SCHEDULE.

In accordance with the National Energy Conservation Act of 1992, water conserving fixtures shall have the following maximum water consumption rates:

Lavatory and kitchens faucets and replacement aerators: 0.158  
Liters/second  
Gravity and Flushometer Tank type toilets: 6.04 liters per flush  
Electromechanical/hydraulic flush toilets: 6.04 liters per flush  
Blowout toilets: 13.21 Liters per flush

#### 2.4.1 Lavatories

Vitreous china lavatories shall be provided with two integral molded lugs on the back-underside of the fixture and drilled for bolting to the wall in a manner similar to the hanger plate.

#### 2.5 BACKFLOW PREVENTERS

Reduced pressure principle assemblies, double check valve assemblies, atmospheric (non-pressure) type vacuum breakers, and pressure type vacuum breakers shall be tested, approved, and listed in accordance with FCCHR-01.

Backflow preventers with intermediate atmospheric vent shall conform to ASSE 1012. Reduced pressure principle backflow preventers shall conform to ASSE 1013. Hose connection vacuum breakers shall conform to ASSE 1011. Pipe applied atmospheric type vacuum breakers shall conform to ASSE 1001. Air gaps in plumbing systems shall conform to ASME A112.1.2. Reduced Pressure Backflow Preventers (RPBP) shall be installed from 300 to 1000 above finished floor and shall be provided with a drainage catch chamber below the intermediate isolation chamber to catch drainage; the catch chamber shall be piped to within 50 mm of the nearest and most convenient floor drain while not creating a tripping hazard with the drain piping.

## 2.6 DRAINS

### 2.6.1 Floor Drains

Floor and shower drains shall consist of a galvanized body, integral seepage pan, and adjustable perforated or slotted chromium-plated bronze, nickel-bronze, or nickel-brass strainer, consisting of grate and threaded collar. Floor drains shall be cast iron except where metallic waterproofing membrane is installed. Drains shall be of double drainage pattern for embedding in the floor construction. The seepage pan shall have weep holes or channels for drainage to the drainpipe. The strainer shall be adjustable to floor thickness. A clamping device for attaching flashing or waterproofing membrane to the seepage pan without damaging the flashing or waterproofing membrane shall be provided when required. Drains shall be provided with threaded or caulked connection. In lieu of a caulked joint between the drain outlet and waste pipe, a neoprene rubber gasket conforming to ASTM C 564 may be installed, provided that the drain is specifically designed for the rubber gasket compression type joint. Floor drains shall conform to ASME A112.21.1M.

#### 2.6.1.1 Drains and Backwater Valves

Drains and backwater valves installed in connection with waterproofed floors or shower pans shall be equipped with bolted-type device to securely clamp flashing.

### 2.6.2 Area Drains

Area drains shall be plain pattern with polished stainless steel perforated or slotted grate and bottom outlet. The drain shall be circular or square with a 305 mm nominal overall width or diameter and 250 mm nominal overall depth. Drains shall be cast iron with manufacturer's standard coating. Grate shall be easily lifted out for cleaning. Outlet shall be suitable for inside caulked connection to drain pipe. Drains shall conform to ASME A112.21.1M.

### 2.6.3 Sight Drains

Sight drains shall consist of body, integral seepage pan, and adjustable strainer with perforated or slotted grate and funnel extension. The strainer shall have a threaded collar to permit adjustment to floor thickness. Drains shall be of double drainage pattern suitable for embedding in the floor construction. A clamping device for attaching flashing or waterproofing membrane to the seepage pan without damaging the flashing or membrane shall be provided for other than concrete construction.

Drains shall have a galvanized heavy cast-iron body and seepage pan and chromium-plated bronze, nickel-bronze, or nickel-brass strainer and funnel combination. Drains shall be provided with threaded or caulked connection and with a separate cast-iron "P" trap, unless otherwise indicated. Drains shall be circular, unless otherwise indicated. The funnel shall be securely mounted over an opening in the center of the strainer. Minimum dimensions shall be as follows:

Area of strainer and collar	0.0232 square meters
Height of funnel	95 mm
Diameter of lower portion	50 mm of funnel
Diameter of upper portion	100 mm of funnel

#### 2.6.4 Roof Drains and Expansion Joints

Roof drains shall conform to ASME A112.21.2M, with dome and integral flange, and shall have a device for making a watertight connection between roofing and flashing. The whole assembly shall be galvanized heavy pattern cast iron. For aggregate surface roofing, the drain shall be provided with a gravel stop. On roofs other than concrete construction, roof drains shall be complete with underdeck clamp, sump receiver, and an extension for the insulation thickness where applicable. A clamping device for attaching flashing or waterproofing membrane to the seepage pan without damaging the flashing or membrane shall be provided when required to suit the building construction. Strainer openings shall have a combined area equal to twice that of the drain outlet. The outlet shall be equipped to make a proper connection to threaded pipe of the same size as the downspout. An expansion joint of proper size to receive the conductor pipe shall be provided. The expansion joint shall consist of a heavy cast-iron housing, brass or bronze sleeve, brass or bronze fastening bolts and nuts, and gaskets or packing. The sleeve shall have a nominal thickness of not less than 3.4 mm. Gaskets and packing shall be close-cell neoprene, O-ring packing shall be close-cell neoprene of 70 durometer. Packing shall be held in place by a packing gland secured with bolts.

#### 2.7 TRAPS

Unless otherwise specified, traps shall be plastic per ASTM F 409 or copper-alloy adjustable tube type with slip joint inlet and swivel. Traps shall be without a cleanout. Tubes shall be copper alloy with walls not less than 0.813 mm thick within commercial tolerances, except on the outside of bends where the thickness may be reduced slightly in manufacture by usual commercial methods. Inlets shall have rubber washer and copper alloy nuts for slip joints above the discharge level. Swivel joints shall be below the discharge level and shall be of metal-to-metal or metal-to-plastic type as required for the application. Nuts shall have flats for wrench grip. Outlets shall have internal pipe thread, except that when required for the application, the outlets shall have sockets for solder-joint connections. The depth of the water seal shall be not less than 51 mm. The interior diameter shall be not more than 3.175 mm over or under the nominal size, and interior surfaces shall be reasonably smooth throughout. A copper alloy "P" trap assembly consisting of an adjustable "P" trap and threaded trap wall nipple with cast brass wall flange shall be provided for lavatories. The assembly shall be a standard manufactured unit and may have a rubber-gasketed swivel joint.

#### 2.8 WATER HEATER (1-DWH-1 and 4-WH-1)

Water heater types and capacities shall be as indicated. Each primary water heater shall have controls adjustable from 32.22 to 48.9 degrees C for Barracks Building or from 32.22 to 60.0 degrees C, for the Community Building, as applicable. Hot water systems utilizing recirculation systems shall be tied into building off-hour controls. The thermal efficiencies and stand by heat losses shall conform to TABLE III as determined by ASHRAE 90.1 for each type of water heater specified. The only exception is that the storage capacity need not meet the standard loss requirement if the tank surface area is not insulated to R-12.5 and if a standing light is not used.

##### 2.8.1 Automatic Storage Type

Heaters shall be complete with temperature gauge, and pressure gauge, and shall have ASME rated combination pressure and temperature relief valve.

### 2.8.2 Gas-Fired Type

Gas-fired water heaters shall conform to ANSI Z21.10.1 when input is 21.975 kW or less or ANSI Z21.10.3 for heaters with input greater than 21.975 kW.

### 2.9 DOMESTIC HOT-WATER STORAGE TANKS (1-DST-1)

Hot-water storage tanks shall be constructed by one manufacturer, ASME stamped for the working pressure, and shall have the National Board (ASME) registration. The standby heat loss shall conform to TABLE III as determined by the requirements of ASHRAE 90.1. Each tank shall be equipped with a thermometer, conforming to ANSI SAMA Z236.1, Type I, Class 3, Range C, style and form as required for the installation, and with 7 inch scale. Thermometer shall have a separable socket suitable for a 20 mm tapped opening. Tanks shall be equipped with pressure gauge. Insulation shall be as specified in Section 15250 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

### 2.10 PUMPS

#### 2.10.1 Circulating Pumps (1-DCP-1, 1-DCP-2, and 4-DCP-1)

Domestic hot water circulating pumps shall be electrically driven, single-stage, centrifugal, with mechanical seals, suitable for the intended service. Pump capacities, efficiencies, motor sizes, speeds, and impeller types shall be as shown. Pump and motor shall be supported by the piping on which it is installed. The shaft shall be one-piece, heat-treated, corrosion-resisting steel with impeller and smooth-surfaced housing of bronze. Motor shall be totally enclosed, fan-cooled and shall have sufficient horsepower for the service required. Pump shall conform to HI-01. Each pump motor shall be equipped with an across-the-line magnetic controller in a NEMA 250, Type 1 enclosure with "START-STOP" switch in cover. Pump motors smaller than Fractional horsepower pump motors shall have integral thermal overload protection in accordance with Section 16415 ELECTRICAL WORK, INTERIOR. Guards shall shield exposed moving parts.

#### 2.10.2 Flexible Connectors

Flexible connectors shall be provided at the suction and discharge of each pump that is 0.746 kW or larger. Connectors shall be constructed of neoprene, rubber, or braided bronze, with Class 150 standard flanges. Flexible connectors shall be line size and suitable for the pressure and temperature of the intended service.

### 2.11 DOMESTIC WATER SERVICE METER

Cold water meter shall be of the positive displacement type conforming to AWWA C700. Meter register may be round or straight reading type, as provided by the local utility. Meter shall be provided with a pulse generator, remote readout register and all necessary wiring and accessories.

## PART 3 EXECUTION

### 3.1 GENERAL INSTALLATION REQUIREMENTS

Vent/waste/soil piping shall be cast-iron or ductile iron. Domestic water piping shall be copper. hubless cast-iron shall be installed under concrete floor slabs. Piping located in air plenums shall conform to NFPA 90A requirements. The plumbing system shall be installed complete with necessary fixtures, fittings, traps, valves, and accessories. Water and drainage piping shall be extended 1525 mm outside the building, unless otherwise indicated. A gate valve and drain shall be installed on the water service line inside the building approximately 150 mm above the floor from

point of entry. Piping shall be connected to the exterior service lines or capped or plugged if the exterior service is not in place. Sewer and water pipes shall be laid in separate trenches, except when otherwise shown. Exterior underground utilities shall be at least 460 mm below the average local frost depth or as indicated on the drawings. If trenches are closed or the pipes are otherwise covered before being connected to the service lines, the location of the end of each plumbing utility shall be marked with a stake or other acceptable means. Valves shall be installed with control no lower than the valve body.

### 3.1.1 Water Pipe, Fittings, and Connections

#### 3.1.1.1 Utilities

The piping shall be extended to fixtures, outlets, and equipment. The hot-water and cold-water piping system shall be arranged and installed to permit draining. The supply line to each item of equipment or fixture, except faucets, flush valves, or other control valves which are supplied with integral stops, shall be equipped with a shutoff valve to enable isolation of the item for repair and maintenance without interfering with operation of other equipment or fixtures. Supply piping to fixtures, faucets, hydrants, shower heads, and flushing devices shall be anchored to prevent movement.

#### 3.1.1.2 Cutting and Repairing

The work shall be carefully laid out in advance, and unnecessary cutting of construction shall be avoided. Damage to building, piping, wiring, or equipment as a result of cutting shall be repaired by mechanics skilled in the trade involved.

#### 3.1.1.3 Protection of Fixtures, Materials, and Equipment

Pipe openings shall be closed with caps or plugs during installation. Fixtures and equipment shall be tightly covered and protected against dirt, water, chemicals, and mechanical injury. Upon completion of the work, the fixtures, materials, and equipment shall be thoroughly cleaned, adjusted, and operated. Safety guards shall be provided for exposed rotating equipment.

#### 3.1.1.4 Mains, Branches, and Runouts

Piping shall be installed as indicated. Pipe shall be accurately cut and worked into place without springing or forcing. Structural portions of the building shall not be weakened. Aboveground piping shall run parallel with the lines of the building, unless otherwise indicated. Branch pipes from service lines may be taken from top, bottom, or side of main, using crossover fittings required by structural or installation conditions. Supply pipes, valves, and fittings shall be kept a sufficient distance from other work and other services to permit not less than 13 mm between finished covering on the different services. Bare and insulated water lines shall not bear directly against building structural elements so as to transmit sound to the structure or to prevent flexible movement of the lines. Water pipe shall not be buried in or under floors. Changes in pipe sizes shall be made with reducing fittings. Use of bushings will not be permitted except for use in situations in which standard factory fabricated components are furnished to accommodate specific excepted installation practice. Change in direction shall be made with fittings, except that bending of pipe 100 mm and smaller will be permitted, provided a pipe bender is used and wide sweep bends are formed. The center-line radius of bends shall be not less than six diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be acceptable.

#### 3.1.1.5 Pipe Drains

Pipe drains indicated shall consist of 20 mm hose bibb with renewable seat and gate valve ahead of hose bibb. At other low points, 20 mm brass plugs or caps shall be provided. Disconnection of the supply piping at the fixture is an acceptable drain.

#### 3.1.1.6 Expansion and Contraction of Piping

Allowance shall be made throughout for expansion and contraction of water pipe. Each hot-water and hot-water circulation riser shall have expansion loops or other provisions such as offsets, changes in direction, etc., where indicated and/or required. Risers shall be securely anchored as required or where indicated to force expansion to loops. Branch connections from risers shall be made with ample swing or offset to avoid undue strain on fittings or short pipe lengths. Horizontal runs of pipe over 15.24 meters in length shall be anchored to the wall or the supporting construction about midway on the run to force expansion, evenly divided, toward the ends. Sufficient flexibility shall be provided on branch runouts from mains and risers to provide for expansion and contraction of piping. Flexibility shall be provided by installing one or more turns in the line so that piping will spring enough to allow for expansion without straining. If mechanical grooved pipe coupling systems are provided, the deviation from design requirements for expansion and contraction may be allowed pending approval of Contracting Officer.

#### 3.1.1.7 Commercial-Type Water Hammer Arresters

Commercial-type water hammer arresters shall be provided on hot- and cold-water supplies and shall be located as generally indicated, with precise location and sizing to be in accordance with PDI WH 201. Water hammer arresters, where concealed, shall be accessible by means of access doors or removable panels. Commercial-type water hammer arresters shall conform to PDI WH 201. Vertical capped pipe columns will not be permitted.

#### 3.1.2 Not applicable.

#### 3.1.3 Joints

Installation of pipe and fittings shall be made in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Joints shall be made up with fittings of compatible material and made for the specific purpose intended.

##### 3.1.3.1 Threaded

Threaded joints shall have American Standard taper pipe threads conforming to ASME B1.20.1. Only male pipe threads shall be coated with graphite or with an approved graphite compound, or with an inert filler and oil, or shall have a polytetrafluoroethylene tape applied.

##### 3.1.3.2 Mechanical Couplings

Grooved mechanical joints shall be prepared according to the coupling manufacturer's instructions. Pipe and groove dimensions shall comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field shall be measured using a "go/no-go" gauge, vernier or dial caliper, or narrow-land micrometer. Groove width and dimension of groove from end of the pipe shall be measured and recorded for each change in grooving tool setup to verify compliance with coupling



manufacturer's tolerances. Grooved joints shall not be used in concealed locations.

#### 3.1.3.3 Union and Flanged

Unions, flanges and mechanical couplings shall not be concealed in walls, ceilings, or partitions. Unions shall be used on pipe sizes 65 mm and smaller; flanges shall be used on pipe sizes 80 mm and larger.

#### 3.1.3.4 Cast Iron Soil, Waste and Vent Pipe

Bell and spigot compression and hubless gasketed clamp joints for soil, waste and vent piping shall be installed per the manufacturer's recommendations.

#### 3.1.3.5 Copper Tube and Pipe

The tube or fittings shall not be annealed when making connections. Connections shall be made with a multiflame torch.

a. Brazed. Brazed joints shall be made in conformance with AWS B2.2, MSS SP-73, and CDA 404/O-RR with flux and are acceptable for line sizes. Copper to copper joints shall include the use of copper-phosphorus or copper-phosphorus-silver brazing metal without flux. Brazing of dissimilar metals (copper to bronze or brass) shall include the use of flux with either a copper-phosphorus, copper-phosphorus-silver or a silver brazing filler metal.

b. Soldered. Soldered joints shall be made with flux and are only acceptable for lines 2 inches and smaller. Soldered joints shall conform to ASME B31.5 and CDA 404/O-RR.

c. Copper Tube Extracted Joint. An extracted mechanical joint may be made in copper tube. Joint shall be produced with an appropriate tool by drilling a pilot hole and drawing out the tube surface to form a collar having a minimum height of three times the thickness of the tube wall. To prevent the branch tube from being inserted beyond the depth of the extracted joint, dimpled depth stops shall be provided. Branch tube shall be notched for proper penetration into fitting to ensure a free flow joint. Extracted joints shall be brazed in accordance with NAPHCC-01 using B-Cup series filler metal in accordance with MSS SP-73. Soldered extracted joints will not be permitted.

#### 3.1.4 Dissimilar Pipe Materials

Connections between ferrous and non-ferrous copper pipe shall be made with dielectric unions or flange waterways.

#### 3.1.5 Corrosion Protection for Buried Pipe and Fittings

##### 3.1.5 Cast Iron and Ductile Iron

Pressure pipe shall have protective coating, a cathodic protection system, and joint bonding. Pipe, fittings, and joints shall have a protective coating. The protective coating shall be completely encasing polyethylene tube or sheet in accordance with AWWA C105. Joints and fittings shall be cleaned, coated with primer, and wrapped with tape. The pipe shall be cleaned, coated, and wrapped prior to pipe tightness testing. Joints and fittings shall be cleaned, coated, and wrapped after pipe tightness testing.

Tape shall conform to AWWA C203 and shall be applied with a 50 percent overlap. Primer shall be as recommended by the tape manufacturer.

### 3.1.6 Pipe Sleeves and Flashing

Pipe sleeves shall be furnished and set in their proper and permanent location.

#### 3.1.6.1 Sleeve Requirements

Pipes passing through concrete or masonry walls or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves are not required for cast-iron soil pipe passing through concrete slab on grade, except where penetrating a membrane waterproof floor. A modular mechanical type sealing assembly may be installed in lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve. The seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and sleeve with corrosion-protected carbon steel bolts, nuts, and pressure plates. The links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal between the pipe and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe and sleeve involved. Sleeves shall not be installed in structural members, except where indicated or approved. Rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective floor, or roof, and shall be cut flush with each surface, except for special circumstances. Pipe sleeves passing through floors in wet areas such as mechanical equipment rooms, lavatories, kitchens, and other plumbing fixture areas shall extend a minimum of 100 mm above the finished floor. Unless otherwise indicated, sleeves shall be of a size to provide a minimum of 6.4 mm clearance between bare pipe and inside of sleeve or between jacket over insulation and sleeves. Sleeves in bearing walls shall be steel pipe or cast-iron pipe. Sleeves for membrane waterproof floors shall be steel pipe, cast-iron pipe, or plastic pipe. Membrane clamping devices shall be provided on pipe sleeves for waterproof floors. Sleeves in nonbearing walls or ceilings may be steel pipe, cast-iron pipe, galvanized sheet metal with lock-type longitudinal seam, or moisture-resistant fiber or plastic. Plastic sleeves shall not be used in nonbearing fire walls, roofs, or floor/ceilings. Except as otherwise specified, the annular space between pipe and sleeve, or between jacket over insulation and sleeve, shall be sealed as indicated with sealants conforming to ASTM C 920 and with a primer, backstop material and surface preparation as specified in Section 07920 JOINT SEALING. Pipes passing through sleeves in concrete floors over crawl spaces shall be sealed as specified above. The annular space between pipe and sleeve or between jacket over insulation and sleeve shall not be sealed for interior walls which are not designated as fire rated. Sleeves through below-grade walls in contact with earth shall be recessed 12.7 mm from wall surfaces on both sides. Annular space between pipe and sleeve shall be filled with backing material and sealants in the joint between the pipe and concrete wall as specified above. Sealant selected for the earth side of the wall shall be compatible with dampproofing/waterproofing materials that are to be applied over the joint sealant.

#### 3.1.6.2 Flashing Requirements

Pipes passing through roof or floor waterproofing membrane shall be installed through a 16 ounce copper flashing, each within an integral skirt or flange. Flashing shall be suitably formed, and the skirt or flange shall extend not less than 205 mm from the pipe and shall be set over the roof or floor membrane in a solid coating of bituminous cement. The flashing shall extend up the pipe a minimum of 255 mm. For cleanouts, the flashing shall

be turned down into the hub and caulked after placing the ferrule. Pipes passing through pitched roofs shall be flashed, using lead or copper flashing, with an adjustable integral flange of adequate size to extend not less than 205 mm from the pipe in all directions and lapped into the roofing to provide a watertight seal. The annular space between the flashing and the bare pipe or between the flashing and the metal-jacket-covered insulation shall be sealed as indicated. Flashing for dry vents shall be turned down into the pipe to form a waterproof joint. Pipes, up to and including 250 mm in diameter, passing through roof or floor waterproofing membrane may be installed through a cast-iron sleeve with caulking recess, anchor lugs, flashing-clamp device, and pressure ring with brass bolts. Flashing shield shall be fitted into the sleeve clamping device. Pipes passing through wall waterproofing membrane shall be sleeved as described above. A waterproofing clamping flange shall be installed.

#### 3.1.6.3 Waterproofing

Waterproofing at floor-mounted water closets shall be accomplished by forming a flashing guard from soft-tempered sheet copper. The center of the sheet shall be perforated and turned down approximately 40 mm to fit between the outside diameter of the drainpipe and the inside diameter of the cast-iron or steel pipe sleeve. The turned-down portion of the flashing guard shall be embedded in sealant to a depth of approximately 40 mm; then the sealant shall be finished off flush to floor level between the flashing guard and drainpipe. The flashing guard of sheet copper shall extend not less than 205 mm from the drainpipe and shall be lapped between the floor membrane in a solid coating of bituminous cement. If cast-iron water closet floor flanges are used, the space between the pipe sleeve and drainpipe shall be sealed with sealant and the flashing guard shall be upturned approximately 40 mm to fit the outside diameter of the drainpipe and the inside diameter of the water closet floor flange. The upturned portion of the sheet fitted into the floor flange shall be sealed.

#### 3.1.6.4 Optional Counterflashing

Instead of turning the flashing down into a dry vent pipe, or caulking and sealing the annular space between the pipe and flashing or metal-jacket-covered insulation and flashing, counterflashing may be accomplished by utilizing the following:

- a. A standard roof coupling for threaded pipe up to 150 mm in diameter.
- b. A tack-welded or banded-metal rain shield around the pipe.

#### 3.1.6.5 Pipe Penetrations of Slab on Grade Floors

Where pipes, fixture drains, floor drains, cleanouts or similar items penetrate slab on grade floors, except at penetrations of floors with waterproofing membrane as specified in paragraphs Flashing Requirements and Waterproofing, a groove 6.4 to 12.7 mm wide by 6.4 to 9.53 mm deep shall be formed around the pipe, fitting or drain. The groove shall be filled with a sealant as specified in Section 07920 JOINT SEALING.

#### 3.1.7 Fire Seal

Where pipes pass through fire walls, fire-partitions, fire-rated pipe chase walls or floors above grade, a fire seal shall be provided as specified in Section 07270 FIRESTOPPING.

### 3.1.8 Supports

#### 3.1.8.1 General

Hangers used to support piping 50 mm and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Pipe guides and anchors shall be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Piping subjected to vertical movement when operating temperatures exceed ambient temperatures shall be supported by variable spring hangers and supports or by constant support hangers. In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run.

#### 3.1.8.2 Pipe Supports and Structural Bracing, Seismic Requirements

Piping and attached valves shall be supported and braced to resist seismic loads as shown. Structural steel required for reinforcement to properly support piping, headers, and equipment, but not shown, shall be provided. Material used for supports shall be as specified in Section 05120 STRUCTURAL STEEL.

#### 3.1.8.3 Pipe Hangers, Inserts, and Supports

Installation of pipe hangers, inserts and supports shall conform to MSS SP-58 and MSS SP-69, except as modified herein.

- a. Types 5, 12, and 26 shall not be used.
- b. Type 3 shall not be used on insulated pipe.
- c. Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for type 18 inserts.
- d. Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and shall have both locknuts and retaining devices furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.
- e. Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.
- f. Type 24 may be used only on trapeze hanger systems or on fabricated frames.
- g. Type 39 saddles shall be used on insulated pipe 100 mm and larger when the temperature of the medium is 15.56 degrees C or higher. Type 39 saddles shall be welded to the pipe.
- h. Type 40 shields shall:
  - (1) Be used on insulated pipe less than 100 mm.
  - (2) Be used on insulated pipe 100 mm and larger when the temperature of the medium is 15.56 degrees C or less.
  - (3) Have a high density insert for pipe 50 mm and larger and for smaller pipe sizes when the insulation is suspected of being visibly compressed, or distorted at or near the shield/insulation interface. High density inserts shall have a density of 128.0 kg/cubic meter or greater.

i. Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 305 mm from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 1525 mm apart at valves. Operating temperatures in determining hanger spacing for PVC or CPVC pipe shall be 48.89 degrees C for PVC and 82.22 degrees C for CPVC. Horizontal pipe runs shall include allowances for expansion and contraction.

j. Vertical pipe shall be supported at each floor, except at slab-on-grade, at intervals of not more than 4570 mm nor more than 2440 mm from end of risers, and at vent terminations. Vertical pipe risers shall include allowances for expansion and contraction.

k. Type 40 shields used on insulated pipe shall have high density inserts with a density of 128 kg/cubic meter or greater.

l. Type 35 guides using steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided to allow longitudinal pipe movement. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered. Lateral restraints shall be provided as needed. Where steel slides do not require provisions for lateral restraint the following may be used:

(1) On pipe 100 mm and larger when the temperature of the medium is 15.56 degrees C or higher, a Type 39 saddle, welded to the pipe, may freely rest on a steel plate.

(2) On pipe less than 100 mm a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.

(3) On pipe 100 mm and larger carrying medium less than 15.56 degrees C a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.

m. Pipe hangers on horizontal insulated pipe shall be the size of the outside diameter of the insulation. The insulation shall be continuous through the hanger on all pipe sizes and applications.

n. Where there are high system temperatures and welding to piping is not desirable, the type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 100 mm or by an amount adequate for the insulation, whichever is greater.

### 3.1.9 Welded Installation

Plumbing pipe weldments shall be as indicated. Changes in direction of piping shall be made with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be permitted. Branch connection may be made with either welding tees or forged branch outlet fittings. Branch outlet fittings shall be forged, flared for improvement of flow where attached to the run, and reinforced against external strains. Beveling, alignment, heat treatment, and inspection of weld shall conform to ASME B31.1. Weld defects shall be removed and repairs made to the weld, or the weld joints shall be entirely removed and rewelded. After filler metal has been removed from its original package, it shall be protected or stored so that its characteristics or welding properties are not affected. Electrodes that have been wetted or that have lost any of their coating shall not be used.

### 3.1.10 Pipe Cleanouts

Pipe cleanouts shall be the same size as the pipe except that cleanout plugs larger than 100 mm will not be required. A cleanout installed in connection with cast-iron soil pipe shall consist of a long-sweep 1/4 bend or one or two 1/8 bends extended to the place shown. An extra-heavy cast-brass or cast-iron ferrule with countersunk cast-brass head screw plug shall be caulked into the hub of the fitting and shall be flush with the floor. Cleanouts in connection with other pipe, where indicated, shall be T-pattern, 90-degree branch drainage fittings with cast-brass screw plugs. Plugs shall be the same size as the pipe up to and including 100 mm. Cleanout tee branches with screw plug shall be installed at the foot of soil and waste stacks, at the foot of interior downspouts, on each connection to building storm drain where interior downspouts are indicated, and on each building drain outside the building. Cleanout tee branches may be omitted on stacks in single story buildings with slab-on-grade construction or where less than 460 mm of crawl space is provided under the floor. Cleanouts on pipe concealed in partitions shall be provided with chromium plated bronze, nickel bronze, nickel brass or stainless steel flush type access cover plates. Round access covers shall be provided and secured to plugs with securing screw. Square access covers may be provided with matching frames, anchoring lugs and cover screws. Cleanouts in finished walls shall have access covers and frames installed flush with the finished wall. Cleanouts installed in finished floors subject to foot traffic shall be provided with a chrome-plated cast brass, nickel brass, or nickel bronze cover secured to the plug or cover frame and set flush with the finished floor. Heads of fastening screws shall not project above the cover surface. Where cleanouts are provided with adjustable heads, the heads shall be cast iron.

## 3.2 WATER HEATERS AND HOT WATER STORAGE TANKS

### 3.2.1 Relief Valves

No valves shall be installed between a relief valve and its water heater or storage tank. The PT relief valve shall be installed where the valve actuator comes in contact with the hottest water in the heater. Whenever possible, the relief valve shall be installed directly in a tapping in the tank or heater; otherwise, the PT valve shall be installed in the hot-water outlet piping. A vacuum relief valve shall be provided on the cold water supply line to the hot-water storage tank or water heater and mounted above and within 150 mm above the top of the tank or water heater.

### 3.2.2 Installation of Gas Water Heater

Installation shall conform to NFPA 54 for gas fired. Storage water heaters that are not equipped with integral heat traps and having vertical pipe risers shall be installed with heat traps directly on both the inlet and outlet. Circulating systems need not have heat traps installed. An acceptable heat trap may be a piping arrangement such as elbows connected so that the inlet and outlet piping make vertically upward runs of not less than 610 mm just before turning downward or directly horizontal into the water heater's inlet and outlet fittings. Commercially available heat traps, specifically designed by the manufacturer for the purpose of effectively restricting the natural tendency of hot water to rise through vertical inlet and outlet piping during standby periods may also be approved.

### 3.2.3 Connections to Water Heaters

Connections of metallic pipe to water heaters shall be made with dielectric unions or flanges.

### 3.3 FIXTURES AND FIXTURE TRIMMINGS

Angle stops, straight stops, stops integral with the faucets, or concealed type of lock-shield, and loose-key pattern stops for supplies with threaded, sweat or solvent weld inlets shall be furnished and installed with fixtures. Where connections between copper tubing and faucets are made by rubber compression fittings, a beading tool shall be used to mechanically deform the tubing above the compression fitting. Exposed traps and supply pipes for fixtures and equipment shall be connected to the rough piping systems at the wall, unless otherwise specified under the item. Floor and wall escutcheons shall be as specified. Drain lines and hot water lines of fixtures for handicapped personnel shall be insulated and do not require polished chrome finish. Plumbing fixtures and accessories shall be installed within the space shown.

#### 3.3.1 Fixture Connections

Where space limitations prohibit standard fittings in conjunction with the cast-iron floor flange, special short-radius fittings shall be provided. Connections between earthenware fixtures and flanges on soil pipe shall be made gastight and watertight with a closet-setting compound or neoprene gasket and seal. Use of natural rubber gaskets or putty will not be permitted. Fixtures with outlet flanges shall be set the proper distance from floor or wall to make a first-class joint with the closet-setting compound or gasket and fixture used.

#### 3.3.2 Flushometer Valves

Flushometer valves shall be secured to prevent movement by anchoring the long finished top spud connecting tube to wall adjacent to valve with approved metal bracket. Flushometer valves for water closets shall be installed 991 above the floor. Bumpers for water closet seats shall be installed on the wall.

#### 3.3.3 Height of Fixture Rims Above Floor

Lavatories, unless otherwise shown, shall be mounted with rim 787 mm above finished floor. Wall-hung drinking fountains and water coolers, unless otherwise shown, shall be installed with rim 1067 mm above floor. Wall-hung service sinks, unless otherwise shown, shall be mounted with rim 710 mm above the floor. Installation of fixtures for use by the physically handicapped shall be in accordance with CABO A117.1.

#### 3.3.4 Shower Bath Outfits

The area around the water supply piping to the mixing valves and behind the escutcheon plate shall be made watertight by caulking or gasketing.

#### 3.3.5 Fixture Supports

Fixture supports for off-the-floor lavatories, urinals, water closets, and other fixtures of similar size, design, and use, shall be of the chair-carrier type. The carrier shall provide the necessary means of mounting the fixture, with a foot or feet to anchor the assembly to the floor slab. Adjustability shall be provided to locate the fixture at the desired height and in proper relation to the wall. Support plates, in lieu of chair carrier, shall be fastened to the wall structure only where it is not possible to anchor a floor-mounted chair carrier to the floor slab.

#### 3.3.5.1 Support for Solid Masonry Construction

Chair carrier shall be anchored to the floor slab. Where a floor-anchored chair carrier cannot be used, a suitable wall plate shall be imbedded in the masonry wall.

#### 3.3.5.2 Support for Cellular-Masonry Wall Construction

Chair carrier shall be anchored to floor slab. Where a floor-anchored chair carrier cannot be used, a suitable wall plate shall be fastened to the cellular wall using through bolts and a back-up plate.

#### 3.3.5.3 Support for Steel Stud Frame Partitions

Chair carrier shall be used. The anchor feet and tubular uprights shall be of the heavy duty design; and feet (bases) shall be steel and welded to a square or rectangular steel tube upright. Wall plates, in lieu of floor-anchored chair carriers, shall be used only if adjoining steel partition studs are suitably reinforced to support a wall plate bolted to these studs.

#### 3.3.5.4 Wall-Mounted Water Closet Gaskets

Where wall-mounted water closets are provided, reinforced wax, treated felt, or neoprene gaskets shall be provided. The type of gasket furnished shall be as recommended by the chair-carrier manufacturer.

#### 3.3.6 Backflow Prevention Devices

Plumbing fixtures, equipment, and pipe connections shall not cross connect or interconnect between a potable water supply and any source of nonpotable water. The backflow prevention device shall be installed where indicated and located so that no part of the device will be submerged. Access shall be provided for maintenance and testing. Each device shall be a standard commercial unit.

#### 3.3.7 Access Panels

Access panels shall be provided for concealed valves and controls, or any item requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced, maintained, or replaced. Access panels shall be as specified in Section 05500 MISCELLANEOUS METAL.

#### 3.3.8 Sight Drains

Sight drains shall be installed so that the indirect waste will terminate 50 mm above the flood rim of the funnel to provide an acceptable air gap.

#### 3.3.9 Traps

Each trap shall be placed as near the fixture as possible, and no fixture shall be double-trapped. Traps installed on cast-iron soil pipe shall be cast iron. Traps installed on steel pipe or copper tubing shall be recess-drainage pattern, or brass-tube type.



### 3.4 VIBRATION-ABSORBING FEATURES

Mechanical equipment, including compressors and pumps, shall be isolated from the building structure by approved vibration-absorbing features, unless otherwise shown. Each foundation shall include an adequate number of standard isolation units. Each unit shall consist of machine and floor or foundation fastening, together with intermediate isolation material, and shall be a standard product with printed load rating. Piping connected to mechanical equipment shall be provided with flexible connectors.

### 3.6 IDENTIFICATION SYSTEMS

#### 3.6.1 Identification Tags

Identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and valve number shall be installed on valves, except those valves installed on supplies at plumbing fixtures. Tags shall be 35 mm minimum diameter, and marking shall be stamped or engraved. Indentations shall be black, for reading clarity. Tags shall be attached to valves with No. 12 AWG, copper wire, chrome-plated beaded chain, or plastic straps designed for that purpose.

#### 3.6.2 Color Coding

Color coding for piping identification shall be as specified in Section 15190 IDENTIFICATION OF PIPING.

#### 3.6.3 Color Coding Scheme for Locating Hidden Utility Components

Scheme shall be provided in buildings having suspended grid ceilings. The color coding scheme shall identify points of access for maintenance and operation of operable components which are not visible from the finished space and installed in the space directly above the suspended grid ceiling.

The operable components shall include valves, dampers, switches, linkages and thermostats. The color coding scheme shall consist of a color code board and colored metal disks. Each colored metal disk shall be approximately 9.5 mm in diameter and secured to removable ceiling panels with fasteners. The fasteners shall be inserted into the ceiling panels so that the fasteners will be concealed from view. The fasteners shall be manually removable without tools and shall not separate from the ceiling panels when panels are dropped from ceiling height. Installation of colored metal disks shall follow completion of the finished surface on which the disks are to be fastened. The color code board shall have the approximate dimensions of 915 mm width, 762 mm height, and 13 mm thickness. The board shall be made of wood fiberboard and framed under glass or 1.6 mm transparent plastic cover. Unless otherwise directed, the color code symbols shall be approximately 19.05 mm in diameter and the related lettering in 13 mm high capital letters. The color code board shall be mounted and located in the mechanical or equipment room. The color code system shall be as indicated below:

<u>Color</u>	<u>System</u>	<u>Item</u>	<u>Location</u>
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### 3.7 ESCUTCHEONS

Escutcheons shall be provided at finished surfaces where bare or insulated piping, exposed to view, passes through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Escutcheons shall be fastened securely to pipe or pipe covering and shall be satin-finish, corrosion-resisting steel, polished chromium-plated zinc alloy, or polished

chromium-plated copper alloy. Escutcheons shall be either one-piece or split-pattern, held in place by internal spring tension or setscrew.

### 3.8 PAINTING

Painting of pipes, hangers, supports, and other iron work, either in concealed spaces or exposed spaces, is specified in Section 09900 PAINTING, GENERAL.

### 3.9 TESTS, FLUSHING, AND STERILIZATION

#### 3.9.1 Plumbing System

The plumbing system shall be tested in accordance with NAPHCC-01.

#### 3.9.2 Defective Work

If inspection or test shows defect repaired as necessary and inspection and tests shall be repeated. Repairs to piping shall be made with new materials. Caulking of screwed joints or holes will not be permitted.

#### 3.9.3 System Flushing

After tests are completed, potable water piping shall be flushed. In general, sufficient water shall be used to produce a minimum water velocity of 0.762 meters/second through piping being flushed. Flushing shall be continued until discharge water shows no discoloration. System shall be drained at low points. Strainer screens shall be removed, cleaned, and replaced in line. After flushing and cleaning, systems shall be prepared for service by immediately filling water piping with clean, fresh potable water. Any stoppage, discoloration, or other damage to the finish, furnishings, or parts of the building due to the Contractor's failure to properly clean the piping system shall be repaired by the Contractor. When the work is complete, the hot-water system shall be adjusted for uniform circulation. Flushing devices and automatic control systems shall be adjusted for proper operation.

#### 3.9.4 Operational Test

Upon completion of and prior to acceptance of the installation, the Contractor shall subject the plumbing system to operating tests to demonstrate satisfactory functional and operational efficiency. Such operating tests shall cover a period of not less than 8 hours for each system and shall include the following information in a report with conclusion as to the adequacy of the system:

- a. Time, date, and duration of test.
- b. Water pressures at the most remote and the highest fixtures.
- c. Operation of each fixture and fixture trim.
- d. Operation of each valve, hydrant, and faucet.
- e. Pump suction and discharge pressures.
- f. Temperature of each domestic hot-water supply.
- g. Operation of each floor and roof drain by flooding with water.
- h. Operation of each vacuum breaker and backflow preventer.

i. Complete operation of each water pressure booster system, including pump start pressure and stop pressure.

j. Compressed air readings at each compressor and at each outlet. Each indicating instrument shall be read at 1/2 hour intervals. The report of the test shall be submitted in quadruplicate. The Contractor shall furnish instruments, equipment, and personnel required for the tests; the Government will furnish the necessary water and electricity.

### 3.9.5 Sterilization

After pressure tests have been made, the entire domestic hot- and cold-water distribution system shall be sterilized. System shall be thoroughly flushed with water of sufficient velocity until all entrained dirt and other foreign material have been removed, before introducing chlorinating material. The chlorinating material shall be hypochlorites or liquid chlorine. Water chlorination procedure shall be in accordance with AWWA M20. The chlorinating material shall be fed into the water piping system at a constant rate at a concentration of at least 50 parts per million (ppm). A properly adjusted hypochlorite solution injected into the main with a hypochlorinator, or liquid chlorine injected into the main through a solution-feed chlorinator and booster pump, shall be used. The chlorine residual shall be checked at intervals to ensure that the proper level is maintained. Chlorine application shall continue until the entire main is filled. The water shall remain in the system for a minimum of 24 hours. Each valve in the system being sterilized shall be opened and closed several times during the contact period to ensure its proper disinfection. Following the 24-hour period, no less than 25 ppm chlorine residual shall remain in the system. Water tanks shall be disinfected by the addition of chlorine directly to the filling water. Following a 6 hour period, no less than 50 ppm chlorine residual shall remain in the tank. The system including the tanks shall then be flushed with clean water until the residual chlorine is reduced to less than one part per million. During the flushing period each valve and faucet shall be opened and closed several times. From several points in the system the Contracting Officer will take samples of water in properly sterilized containers for bacterial examination. The samples of water shall be tested for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with AWWA-01. The testing method used shall be either the multiple-tube fermentation technique or the membrane-filter technique. The sterilizing shall be repeated until tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in the samples for at least 2 full days. The system will not be accepted until satisfactory bacteriological results have been obtained.

### 3.10 PLUMBING FIXTURE SCHEDULE

#### P-1 WATER CLOSET:

Siphon-jet, elongated bowl, top supply spud, ASME A112.19.2M, wall mounted. Floor flange shall be copper alloy or cast iron.

Gasket shall be wax type.

Seat - CID A-A-238, Type A, white plastic, elongated, open front.

Flushometer Valve - ASSE 1037, large diaphragm type with non-hold-open feature, backcheck angle control stop, and vacuum breaker. Minimum upper chamber inside diameter of not less than 66.7 mm at the point where the diaphragm is sealed between the upper and lower chambers. The maximum water use shall be 6.038 liters per flush.

## P-1A WATER CLOSET

Vitreous china with 5.66 Liter per flush, tank, and tank locks, **wall mounted** coupled rear discharge design with elongated bowl. Factory installed tank gasket and bolts.

Flush Tank - An adequate quantity of water shall be provided to flush and clean the fixture served. The water supply to flush tanks equipped for manual flushing shall be controlled by a float valve or other automatic device designed to refill the tank after each discharge, and to completely shut off the water flow to the tank when the tank is filled to operational capacity. Water closets having their flush valve seat located below the flood level rim of the closet bowl shall have a ballcock installed within a sheath or in a separate and isolated compartment of the tank, both to have visible discharge onto the floor in case of failure. Provision shall be made to automatically supply water to the fixture so as to refill the trap seal after each flushing. The water supply to flush tanks equipped for automatic flushing shall be controlled by a suitable timing device. Ballcocks shall meet ASSE 1002.

Flush Valve in Flush Tank - Flush valve seats in tanks for flushing water closets shall be at least 25.4 mm above the flood level rim of the bowl connected thereto, except in approved water closet and flush tank combinations designed so that when the tank is flushed and the fixture is clogged or partially clogged, the flush valve shall close tightly so that water will not spill continuously over the rim of the bowl or back flow from the bowl to the tank.

## P-2 WATER CLOSET HANDICAPPED:

Top rim of bowl shall be 460 mm above the floor; other features are the same as P-1.

## P-3 URINAL:

Wall hanging, with integral trap and extended shields, ASME A112.19.2M siphon jet, Top supply connection, back outlet.

Flushometer Valve - Similar to Flushometer Valve for P-1. The maximum water use shall be 3.77 liters per flush.

## BATHTUB:

Refer to P-13 SHOWER/BATHTUB COMBINATION, herein below.

## P-5 LAVATORY:

All metal trim materials and hardware shall be chromium plated.

FS WW-P-541/4 (applicable portions only, Fed Spec requirements shall not override requirements herein or shown on project documents) material is acrylic integral with countertop, reference architectural project document requirements for countertop and sink, bowl shape shall be rectangular, plan dimensions shall be 540 mm wide by 400 mm deep with a bowl depth of 175 mm .

Faucet - Faucets shall be 2 hole countertop mount, 100 mm center set type with swiveling gooseneck spout with aerator. Valves shall be copper alloy. Flow shall be limited to 0.158 Liters/second at a flowing pressure of 551.6 kPa.

Handles - indexed metal. Cast, formed, or drop forged copper alloy.

Drain - Strainer shall be copper alloy or stainless steel; Pop-up drain shall include stopper, lift rods, jam nut, washer, and tail piece. See paragraph FIXTURES for optional plastic accessories.

P-6 WHEELCHAIR LAVATORY:

All metal trim materials and hardware shall be chromium plated.

FS WW-P-541/4 (applicable portions only, Fed Spec requirements shall not override requirements herein or shown on project documents) material is acrylic integral with countertop, reference architectural project document requirements for countertop and sink, bowl shape shall be oval, plan dimensions (oval major and minor axes) shall be 540 mm wide by 400 mm deep with a bowl depth of 175 mm .

Faucet - Faucets shall be 2 hole countertop mount, 100 mm center set type with fixed gooseneck spout with aerator. Valves shall be copper alloy. Flow shall be limited to 0.158 Liters/second at a flowing pressure of 551.6 kPa.

Handles - blade type. Cast, formed, or drop forged copper alloy.

Drain - Strainer shall be copper alloy or stainless steel; Pop-up drain shall include stopper, lift rods, jam nut, washer, and tail piece. See paragraph FIXTURES for optional plastic accessories.

Hot water supply and drain piping shall be insulated in accordance with Section 15250 thermal insulation for mechanical systems.

P-7 KITCHEN SINK:

All metal trim materials and hardware shall be chromium plated.

Ledge back with 4 holes for faucet and pull out sprayer; sink shall be double bowl and shall be stainless steel with manufacturers sound damping undercoating. Overall plan dimension of sink shall be 840 mm wide by 560 mm deep, back ledge depth of 115 mm. Each rectangular bowl shall be 355 mm wide by 405 deep.

Faucet and Spout - Faucet is mixing valve type, 4 hole installation, 200 mm center with 200 mm long spout which swings 360 degrees and is manufactured of cast or wrought copper alloy with internal threaded aerator. Flow shall be limited to 0.158 Liter/second at a flowing water pressure of 551.6 kPa.

Handle - Single lever mixing type, chromium plated, cast copper alloy, wrought copper alloy, or stainless steel.

Drain Assembly - Plug, cup strainer, crossbars, jam nuts, washers, couplings, stopper, etc. shall be copper alloy or stainless steel.

P-8 SERVICE SINK:

Enameled cast iron, copper alloy or stainless steel rim guard, FS WW-P-541/5 corner, floor mounted 710 mm square, 170 mm deep.

Faucet and Spout - Cast or wrought copper alloy, with top or bottom brace and shall include backflow preventer. Faucets shall have replaceable seat and the washer shall rotate onto the seat. Handles shall be lever four arm type. Strainers shall have internal threads.

Drain Assembly - Plug, cup strainer, crossbars, jam nuts, washers, couplings, stopper, etc. shall be copper alloy or stainless steel.

Trap - Cast iron.

P-8A MUD SINK:

Mud sink shall be manufactured from 16 gauge 304 Stainless Steel (S.S.) Bowl shall be minimum 610 mm by 610 mm by 305 mm deep or other dimensions as modified herein below, and shall have min. 190 mm high rear splash plate and 64 mm high front lip. Working height shall be 940 mm above finished floor. Water level shall be 305 mm, flood level shall be 380 mm above bottom of sink. Sink shall be provided with cross-braced S.S. legs and feet.

Faucet and spout shall be rough plated chrome finish with threaded spout, wall to center of spout outlet of 190 mm, equipped with vacuum breaker, 76 mm valve handles, washerless ceramic valving, inside threaded couplings, pail hook and wall brace.

Drain Assembly - Plug, cup strainer, crossbars, jam nuts, washers, couplings, stopper, etc. shall be copper alloy or stainless steel.

BARRACKS BUILDING - Each mud sink assembly shall have overall width of 760 mm and overall horizontal depth of 780 mm. Drain board not required for Barracks Building.

COMMUNITY BUILDING - Each mud sink assembly/unit shall have overall width of 900 mm and overall depth of 700 mm. Bowl dimension shall be 750mm long and 355mm wide (min). Drain board shall be 460 mm wide.

P-13 SHOWER/BATHTUB COMBINATION:

Shower heads, CID A-A-240 other than emergency showers, shall include a non-removable, vandal resistant, tamperproof device to limit shower flow to 0.174 Liters/second when tested in accordance with ASME A112.18.1M.

Wall Mounted: Shower heads shall be a nonadjustable spray, stainless steel or chromium plated brass with ball joint. Handles shall be chromium plated, die cast zinc alloy. Control valves shall be copper alloy and have metal integral parts of copper alloy, nickel alloy or stainless steel. Valves shall be pressure compensating, thermostatic mixing type.

Bath Showers: Bath showers shall include bathtub spout, shower head, valves, diverters. A shower head mounting with ball joint and head integral with a formed wall plate shall be provided. Diverter shall be integral with single mixing valves or mounted hot and cold water valves. Tub spout shall be copper alloy.

Bathtub shall be straight front, recessed, 1524 mm by 762 mm by 356 mm, Federal Specification WW-P-541/3, enameled cast iron, raised bottom.

Drain Assembly - Plug, cup strainer, overflow assembly, washers, couplings, lift and turn, stopper, fittings, etc. shall be brass, cast copper alloy, or wrought copper alloy. See paragraph FIXTURES for optional plastic accessories.

## P-15 WATER COOLER DRINKING FOUNTAINS:

Water cooler drinking fountains shall be for handicapped use, shall be self contained, conform to ARI 1010, use one of the halogenated fluorocarbons as a refrigerant, have a capacity to deliver 30.19 Liter/hour of water at 10.0 degrees C with an inlet water temperature of 26.67 degrees C while residing in a room environment of 32.22 degrees C, and have self-closing valves. Self-closing valves shall have automatic stream regulators, have a flow control capability, have a push button actuation or have a cross-shaped index metal turn handle without a hood. Exposed surfaces of stainless steel shall have No. 4 general polish finish. Spouts shall provide a flow of water at least 100 mm high so as to allow the insertion of a cup or glass under the flow of water.

Handicapped - Handicapped units shall be surface wall-mounted. The dimensions shall be 380 mm wide, 510 mm deep, with a back height of 150 to 205 mm. The unit shall clear the floor or ground by at least 205 mm. A clear knee space shall exist between the bottom of the bowl and the floor or ground of at least 685 mm and between the front edge of the bowl and the body of the unit of at least 205 mm. A 205 mm wide clear space shall exist on both sides of the unit. The spout height shall be no more than 915 mm above the floor or ground to the outlet. The spout shall be at the front of the unit and direct the water flow in a trajectory that is parallel or nearly parallel to the front of the unit. The bowl shall be 165 mm high, made of corrosion resisting steel and be for interior installation.

## P-17 GARBAGE DISPOSAL MACHINES:

Garbage disposals machines shall be in accordance with CID A-A-50012.

## P-19 DISHWASHING MACHINES:

Household diswashing machine shall coform to UL 749 and ASSE 1006, sized as indicated.

## 3.11 POSTED INSTRUCTIONS

Framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, shall be posted where directed. Condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system shall be prepared in typed form, framed as specified above for the wiring and control diagrams and posted beside the diagrams. The framed instructions shall be posted before acceptance testing of the systems.

## 3.12 PERFORMANCE OF WATER HEATING EQUIPMENT

Standard rating condition terms are as follows:

- EF Energy factor, overall efficiency.
- ET Thermal efficiency with 38.9 degree C delta T.
- EC Combustion efficiency, 100 percent - flue loss when smoke = 0 (trace is permitted).
- SL Standby loss in W/sq. meter based on 44.4 degrees C delta T, or in percent per hour based on nominal 50.0 degrees C delta T.
- HL Heat loss of tank surface area.
- V Storage volume in gallons

3.12.1 Storage Water Heaters

3.12.1.1 Gas

a. Storage capacity of 377.4 liters or less, and input rating of 21.975 kW or less: minimum EF shall be 0.62-0.0019V per 10 CFR 430.

b. Storage capacity of more than 377.4 liters - or input rating more than 21.975 kW: Et shall be 77 percent; maximum SL shall be  $1.3+38/V$ , per ANSI Z21.10.3.



TABLE I  
PIPE AND FITTING MATERIALS FOR  
DRAINAGE, WASTE, AND VENT PIPING SYSTEMS

Item No.	Pipe and Fitting Materials	Service					
		A	B	C	D	E	F
1	Cast iron soil pipe and fittings, hub and spigot, ASTM A 74 with compression gaskets	X	X	X	X	X	
2	Cast iron pipe and fittings hubless, CISPI 301 and ASTM A 888	X	X	X	X		
3	Cast iron drainage fittings, threaded, ASME B16.12 for use with Item 10	X			X	X	
4	Cast iron screwed fittings (threaded) ASME B16.4 for use with Item 10				X	X	
5	Grooved pipe couplings, ferrous and non-ferrous pipe ASTM A 536 and ASTM A 47	X	X		X	X	
6	Ductile iron grooved joint fittings for ferrous pipe ASTM A 536 and ASTM A 47 for use with Item 5	X	X		X	X	
7	Bronze sand casting grooved joint pressure fittings for non-ferrous pipe ASTM B 584, for use with Item 5 ASTM A 47 for use with Item 5	X	X		X	X	
8	Wrought copper grooved joint pressure pressure fittings for non-ferrous pipe ASTM B 75 C12200, ASTM B 152 C11000, ASME B16.22 ASME B16.22 for use with Item 5	X	X				
9	Malleable-iron threaded fittings, galvanized ASME B16.3 for use with Item 10				X	X	
10	Steel pipe, seamless galvanized, ASTM A 53, Type S, Grade B - Not applicable.						
11	Seamless red brass pipe, ASTM B 43				X	X	
12	Bronzed flanged fittings, ASME B16.24 for use with Items 11 and 14				X	X	
13	Cast copper alloy solder joint pressure fittings, ASME B16.18 for use with Item 14				X	X	
14	Seamless copper pipe, ASTM B 42						X
15	Cast bronze threaded fittings, ASME B16.15				X	X	
16	Copper drainage tube, (DWV), ASTM B 306	X*	X	X*	X	X	
17	Wrought copper and wrought alloy solder-joint drainage fittings. ASME B16.29	X	X	X	X		
18	Cast copper alloy solder joint drainage fittings, DWV, ASME B16.23	X	X	X	X	X	

A - Underground Building Soil, Waste and Storm Drain

B - Aboveground Soil, Waste, Drain In Buildings

C - Underground Vent

D - Aboveground Vent

E - Interior Rainwater Conductors Aboveground

F - Corrosive Waste And Vent Above And Belowground

\* - Hard Temper

TABLE II  
PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS

Item No.	Pipe and Fitting Materials	Service			
		A	B	C	D
1	Seamless red brass pipe, ASTM B 43	X	X	X	
2	Bronze flanged fittings, ASME B16.24 for use with Item 6	X	X		X
3	Seamless Copper pipe, ASTM B 42	X	X		X
4	Seamless copper water tube, ASTM B 88	X	X		X
5	Seamless and welded copper distribution tube (type D) ASTM B 641	X**	X**	X**	X***
6	Cast Bronze threaded fittings, ASME B16.15 for use with Items 6 and 7	X**	X**	X**	X*** *
7	Wrought copper and bronze solder-joint pressure fittings, ASME B16.22 for use with Items 6 and 7	X	X		X
8	Cast copper alloy solder-joint pressure fittings, ASME B16.18 for use with items 6 and 7	X	X	X	X
9	Bronze and sand castings grooves joint pressure fittings for non-ferrous pipe ASTM B 584, for use with Item 2	X	X	X	
10	Nipples, pipe threaded ASTM A 733	X	X	X	

A - Cold Water Aboveground

B - Hot Water 80 degrees F Maximum Aboveground

C - Compressed Air Lubricated

D - Cold Water Service Belowground

Indicated types are minimum wall thicknesses.

\*\* - Type L - Hard

\*\*\* - Type K - Hard temper with brazed joints only or type K-soft temper without joints in or under floors

\*\*\*\* - In or under slab floors only brazed joints

TABLE III  
STANDARD RATING CONDITIONS AND  
MINIMUM PERFORMANCE RATINGS FOR WATER HEATING EQUIPMENT

Fuel	Storage Capacity, Liters	Input Rating	Test Procedure	Minimum Performance
A. STORAGE WATER HEATERS				
Gas	380 maximum	22 kW	10 CFR 430	EF 0.62 - 0.0019V minimum
Gas	380 or minimum	22 kW	ANSI Z21.10.3	ET 7 percent; SL 1.3+38/V maximum
B. UNFIRED HOT WATER STORAGE				
Volumes and inputs: maximum HL shall be 20.5 W/sq. meter				
C. INSTANTANEOUS WATER HEATER - Not applicable.				
D. POOL HEATER - Not applicable.				

## TERMS:

EF Energy factor, overall efficiency.

ET Thermal efficiency with 21 degrees C delta T.

EC Combustion efficiency, 100 percent - flue loss when smoke 0 (trace is permitted).

SL Standby loss in W/0.09 sq. m. based on 27 degrees C delta T, or in percent per hour

based on nominal 32 degrees C delta T.

HL Heat loss of tank surface area

V Storage volume in gallons

## SECTION 15488

## GAS PIPING SYSTEMS

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN GAS ASSOCIATION (AGA)

AGA-01 (1989) A.G.A. Plastic Pipe Manual for Gas Service

## AMERICAN NATIONAL STANDARDS INSTITUTE

ANSI Z21.45 (1992; Z21.4a; Z21.4b) Flexible Connectors of Other Than All-Metal Construction for Gas Appliances

ANSI Z21.69 (1992; Z21.69a) Connectors for Movable Gas Appliances

## AMERICAN PETROLEUM INSTITUTE (API)

API Spec 6D (1994) Specification for Pipeline Valves (Gate, Plug, Ball, and Check Valves)

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 539 (1990a) Electric-Resistance-Welded Coiled Steel Tubing for Gas and Fuel Oil Lines

## AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1 (1983; R 1992) Pipe Threads, General Purpose (Inch)

ASME B16.3 (1992) Malleable Iron Threaded Fittings

ASME B16.5 (1988; Errata Oct 88; B16.5a) Pipe Flanges and Flanged Fittings

ASME B16.9 (1993) Factory-Made Wrought Steel Buttwelding Fittings

ASME B16.11 (1991) Forged Fittings, Socket-Welding and Threaded

ASME B16.21 (1992) Nonmetallic Flat Gaskets for Pipe Flanges

ASME B16.33	(1990) Manually Operated Metallic Gas Valves for Use in Gas Piping Systems Up to 125 psig (Sizes 1/2 through 2)
ASME B31.1	(1995) Power Piping
ASME B31.2	(1968) Fuel Gas Piping
ASME B36.10M	(1985; R 1994) Welded and Seamless Wrought Steel Pipe
ASME BPV IX	(1995; Addenda Dec 1995) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS  
INDUSTRY (MSS)

MSS SP-25	(1993) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(1993) Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-69	(1991) Pipe Hangers and Supports - Selection and Application

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(1992) National Fuel Gas Code
NFPA 70	(1996) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL-06	(1994; Supple; Rev thru March 1996) Gas and Oil Equipment Directory
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## 1.2 GENERAL REQUIREMENTS

### 1.2.1 Welding

Piping shall be welded in accordance with qualified procedures using performance qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPV IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified at least 24 hours in advance of tests and the tests shall be performed at the work site if practicable. The Contracting Officer shall be furnished with a copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators. The welder or welding operator shall apply his assigned symbol near each weld he makes as a permanent record. Structural members shall be welded in accordance with Section 05055 WELDING, STRUCTURAL.

### 1.2.2 Jointing Thermoplastic and Fiberglass Piping

Piping shall be jointed by performance qualified joiners using qualified procedures in accordance with AGA-01. Plastic Pipe Manual for Gas Service. The Contracting Officer shall be furnished with a copy of qualified procedures and list of and identification symbols of qualified joiners.

### 1.2.3 Standard Products

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Asbestos or products containing asbestos shall not be used. Manufacturer's descriptive data and installation instructions shall be submitted for approval for compression-type mechanical joints used in joining dissimilar materials and for insulating joints. Valves, flanges and fittings shall be marked in accordance with MSS SP-25.

### 1.2.4 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

#### SD-01 Data

Qualifications; FIO.

Qualified procedures and a list of names and identification symbols of qualified welders and welding operators.

#### SD-04 Drawings

Gas Piping System; GA.

Drawings showing location, size and all branches of pipeline; location of all required shutoff valves; and instructions necessary for the installation of connectors and supports.

## 2 PRODUCTS

### 2.1 PIPE AND FITTINGS

#### 2.1.1 Steel Pipe, Joints, and Fittings

Steel pipe shall conform to ASME B36.10M. Malleable-iron threaded fittings shall conform to ASME B16.3. Steel pipe flanges and flanged fittings including bolts, nuts, and bolt pattern shall be in accordance with ASME B16.5. Wrought steel butt welding fittings shall conform to ASME B16.9.

Socket welding and threaded forged steel fittings shall conform to ASME B16.11.

#### 2.1.2 Steel Tubing, Joints and Fittings

Steel tubing shall conform to ASTM A 539. Tubing joints shall be made up with gas tubing fittings recommended by the tubing manufacturer.

#### 2.1.3 Sealants for Steel Pipe Threaded Joints

Joint sealing compound shall be listed in UL-06, Class 20 or less. Tetrafluoroethylene tape shall conform to UL-06.

#### 2.1.4 Identification

Pipe flow markings and metal tags shall be provided as required.

#### 2.1.5 Flange Gaskets

Gaskets shall be nonasbestos compressed material in accordance with ASME B16.21, 1.6 mm thickness, full face or self-centering flat ring type. The gaskets shall contain aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR) suitable for a maximum 316 degrees C service. NBR binder shall be used for hydrocarbon service.

#### 2.1.6 Pipe Threads

Pipe threads shall conform to ASME B1.20.1.

#### 2.1.7 Escutcheons

Escutcheons shall be chromium-plated steel or chromium-plated brass, either one piece or split pattern, held in place by internal spring tension or set screw.

#### 2.1.8 Insulating Pipe Joints

##### 2.1.8.1 Insulating Joint Material

Insulating joint material shall be provided between flanged or threaded metallic pipe systems where shown to control galvanic or electrical action.

##### 2.1.8.2 Threaded Pipe Joints

Joints for threaded pipe shall be steel body nut type dielectric unions with insulating gaskets.

##### 2.1.8.3 Flanged Pipe Joints

Joints for flanged pipe shall consist of full face sandwich-type flange insulating gasket of the dielectric type, insulating sleeves for flange bolts, and insulating washers for flange nuts.

### 2.1.9 Flexible Connectors

Flexible connectors for connecting gas utilization equipment to building gas piping shall conform to ANSI Z21.45. Flexible connectors for movable food service equipment shall conform to ANSI Z21.69.

## 2.2 VALVES

Valves shall be suitable for shutoff or isolation service and shall conform to the following:

### 2.2.1 Valves 50 mm and Smaller

Valves 50 mm and smaller shall conform to ASME B16.33 and shall be of materials and manufacture compatible with system materials used.

### 2.2.2 Valves 65 mm and Larger

Valves 65 mm and larger shall be carbon steel conforming to API Spec 6D, Class 150.

## 2.3 PIPE HANGERS AND SUPPORTS

Pipe hangers and supports shall conform to MSS SP-58 and MSS SP-69.

## 2.4 METERS, REGULATORS AND SHUTOFF VALVES

Meters, regulators and shutoff valves shall be as specified in Section 02685 GAS DISTRIBUTION SYSTEM.

## 3 EXECUTION

### 3.1 EXCAVATION AND BACKFILLING

Earthwork shall be as specified in Section 02222 EXCAVATION, TRENCHING AND BACKFILLING FOR UTILITIES SYSTEMS.

### 3.2 GAS PIPING SYSTEM

Gas piping system shall be from the point of delivery, defined as the outlet of the service regulator, specified in Section 02685 GAS DISTRIBUTION SYSTEM, to the connections to each gas utilization device.

#### 3.2.1 Protection of Materials and Components

Pipe and tube openings shall be closed with caps or plugs during installation. Equipment shall be protected from dirt, water, and chemical or mechanical damage. At the completion of all work, the entire system shall be thoroughly cleaned.

#### 3.2.2 Workmanship and Defects

Piping, tubing and fittings shall be clear and free of cutting burrs and defects in structure or threading and shall be thoroughly brushed and chip-and scale-blown. Defects in piping, tubing or fittings shall not be repaired. When defective piping, tubing, or fittings are located in a system, the defective material shall be replaced.



### 3.3 PROTECTIVE COVERING

#### 3.3.1 Underground Metallic Pipe

Buried metallic piping shall be protected from corrosion with protective coatings as specified in Section 02685 GAS DISTRIBUTION SYSTEM. When dissimilar metals are joined underground, gas tight insulating fittings shall be used.

#### 3.3.2 Aboveground Metallic Piping Systems

##### 3.3.2.1 Ferrous Surfaces

Shop primed surfaces shall be touched up with ferrous metal primer. Surfaces that have not been shop primed shall be solvent cleaned. Surfaces that contain loose rust, loose mill scale and other foreign substances shall be mechanically cleaned by power wire brushing and primed with ferrous metal primer. Primed surface shall be finished with two coats of exterior oil paint.

##### 3.3.2.2 Nonferrous Surfaces

Except for aluminum alloy pipe, nonferrous surfaces shall not be painted. Surfaces of aluminum alloy pipe and fittings shall be painted to protect against external corrosion where they contact masonry, plaster, insulation, or are subject to repeated wettings by such liquids as water, detergents or sewage. The surfaces shall be solvent-cleaned and treated with vinyl type wash coat. A first coat of aluminum paint and a second coat of alkyd gloss enamel or silicone alkyd copolymer enamel shall be applied.

### 3.4 INSTALLATION

Installation of the gas system shall be in conformance with the manufacturer's recommendations and applicable provisions of NFPA 54, AGA-01, and as indicated. Pipe cutting shall be done without damage to the pipe. Unless otherwise authorized, cutting shall be done by an approved type of mechanical cutter. Wheel cutters shall be used where practicable. On steel pipe 150 mm and larger, an approved gas cutting and beveling machine may be used. Cutting of thermoplastic and fiberglass pipe shall be in accordance with AGA-01.

#### 3.4.1 Metallic Piping Installation

Underground piping shall be buried a minimum of 450 mm below grade. Changes in direction of piping shall be made with fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be permitted. Branch connection may be made with either tees or forged branch outlet fittings. Branch outlet fittings shall be forged, flared for improvement of flow where attached to the run, and reinforced against external strains. Aluminum alloy pipe shall not be used in exterior locations or underground.

#### 3.4.2 Metallic Tubing Installation

Metallic tubing shall be installed using gas tubing fittings approved by the tubing manufacturer. Branch connections shall be made with tees. All tubing end preparation shall be made with tools designed for the purpose.

Aluminum alloy tubing shall not be used in exterior locations or underground.

#### 3.4.3 Piping Buried Under Buildings

Underground piping installed beneath buildings shall be run in a steel pipe casing protected from corrosion with protective coatings as specified in Section 02685 GAS DISTRIBUTION SYSTEM. The casing shall extend at least 100 mm outside the building. The pipe shall have spacers and end bushings to seal at both ends to prevent the entrance of water and escape of gas. A vent line from the annular space shall extend above grade outside to a point where gas will not be a hazard and shall terminate in a rain- and insect-resistant fitting.

#### 3.4.4 Concealed Piping in Buildings

When installing piping which is to be concealed, unions, tubing fittings, running threads, right- and left-hand couplings, bushings, and swing joints made by combinations of fittings shall not be used.

##### 3.4.4.1 Piping in Partitions

Concealed piping shall be located in hollow rather than solid partitions. Tubing passing through walls or partitions shall be protected against physical damage.

#### 3.4.5 Aboveground Piping

Aboveground piping shall be run as straight as practicable along the alignment indicated and with a minimum of joints. Piping shall be separately supported. Exposed horizontal piping shall not be installed farther than 150 mm from nearest parallel wall in laundry areas where clothes hanging could be attempted.

#### 3.4.6 Final Gas Connections

Unless otherwise specified herein, final connections shall be made with rigid metallic pipe and fittings. Final connections to kitchen ranges and cooktops shall be made using flexible connectors not less than 1.02 m long. Flexible connectors may be used for final connections to residential dryers. In addition to cautions listed in instructions required by ANSI standards for flexible connectors, insure that flexible connectors do not pass through equipment cabinet. Provide accessible gas shutoff valve and coupling for each item of gas equipment.

### 3.5 PIPE JOINTS

Pipe joints shall be designed and installed to effectively sustain the longitudinal pull-out forces caused by contraction of the piping or superimposed loads.

#### 3.5.1 Threaded Metallic Joints

Threaded joints in metallic pipe shall have tapered threads evenly cut and shall be made with UL approved graphite joint sealing compound for gas service or tetrafluoroethylene tape applied to the male threads only. Threaded joints up to 40 mm in diameter may be made with approved

tetrafluoroethylene tape. Threaded joints up to 50 mm in diameter may be made with approved joint sealing compound. After cutting and before threading, pipe shall be reamed and burrs shall be removed. Caulking of threaded joints to stop or prevent leaks shall not be permitted.

### 3.5.2 Welded Metallic Joints

Beveling, alignment, heat treatment, and inspection of welds shall conform to ASME B31.2. Weld defects shall be removed and repairs made to the weld, or the weld joints shall be entirely removed and rewelded. After filler metal has been removed from its original package, it shall be protected or stored so that its characteristics or welding properties are not affected adversely. Electrodes that have been wetted or have lost any of their coating shall not be used.

### 3.5.3 Flared Metallic Tubing Joints

Flared joints in metallic tubing shall be made with special tools recommended by the tubing manufacturer. Flared joints shall be used only in systems constructed from nonferrous pipe and tubing, when experience or tests have demonstrated that the joint is suitable for the conditions, and when adequate provisions are made in the design to prevent separation of the joints. Metallic ball sleeve compression-type tubing fittings shall not be used for tubing joints.

### 3.5.4 Solder or Brazed Joints

Joints in metallic tubing and fittings shall be made with materials and procedures recommended by the tubing supplier. Joints shall be brazed with material having a melting point above 538 degrees C (1000 degrees F). Brazing alloys shall not contain phosphorous.

## 3.6 PIPE SLEEVES

Pipes passing through concrete or masonry walls or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves shall not be installed in structural members except where indicated or approved. All rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective wall, floor or roof, and shall be cut flush with each surface, except in mechanical room floors not located on grade where clamping flanges or riser pipe clamps are used. Sleeves in mechanical room floors above grade shall extend at least 100 mm above finish floor. Unless otherwise indicated, sleeves shall be large enough to provide a minimum clearance of 6.4 mm all around the pipe. Sleeves in bearing walls, waterproofing membrane floors, and wet areas shall be steel pipe. Sleeves in nonbearing walls, floors, or ceilings may be steel pipe, galvanized sheet metal with lock-type longitudinal seam, or moisture-resistant fiber or plastic. For penetrations of fire walls, fire partitions and floors which are not on grade, the annular space between the pipe and sleeve shall be sealed with firestopping material and sealant that meet the requirement of Section 07270 FIRESTOPPING.

## 3.7 PIPES PENETRATING WATERPROOFING MEMBRANES

Pipes penetrating waterproofing membranes shall be installed as specified in Section 15400 PLUMBING, GENERAL PURPOSE.

### 3.8 FIRE SEAL

Penetrations of fire rated partitions, walls and floors shall be in accordance with Section 07270 FIRESTOPPING.

### 3.9 ESCUTCHEONS

Escutcheons shall be provided for all finished surfaces where gas piping passes through floors, walls, or ceilings except in boiler, utility, or equipment rooms.

### 3.10 SPECIAL REQUIREMENTS

Drips, grading of the lines, freeze protection, and branch outlet locations shall be as shown and shall conform to the requirements of NFPA 54.

### 3.11 BUILDING STRUCTURE

Building structure shall not be weakened by the installation of any gas piping. Beams or joists shall not be cut or notched.

### 3.12 PIPING SYSTEM SUPPORTS

Gas piping systems in buildings shall be supported with pipe hooks, metal pipe straps, bands or hangers suitable for the size of piping or tubing. Gas piping system shall not be supported by other piping. Spacing of supports in gas piping and tubing installations shall conform to the requirements of NFPA 54. The selection and application of supports in gas piping and tubing installations shall conform to the requirements of MSS SP-69. In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for any of the individual pipes in the multiple pipe run. The clips or clamps shall be rigidly connected to the common base member. A clearance of 3.2 mm shall be provided between the pipe and clip or clamp for all piping which may be subjected to thermal expansion.

### 3.13 ELECTRICAL BONDING AND GROUNDING

A gas piping system within a building shall be electrically continuous and bonded to a grounding electrode as required by NFPA 70.

### 3.14 SHUTOFF VALVE

Main gas shutoff valve controlling the gas piping system shall be easily accessible for operation and shall be installed as indicated, protected from physical damage, and marked with a metal tag to clearly identify the piping system controlled.

### 3.15 CATHODIC PROTECTION

Cathodic protection shall be provided for underground ferrous gas piping as specified in Section 16642 CATHODIC PROTECTION SYSTEM IMPRESSED CURRENT.

### 3.16 TESTING

Before any section of a gas piping system is put into service, it shall be carefully tested to assure that it is gas tight. Prior to testing, the

system shall be blown out, cleaned and cleared of all foreign material. Each joint shall be tested by means of an approved gas detector, soap and water, or an equivalent nonflammable solution. Testing shall be completed before any work is covered, enclosed, or concealed. All testing of piping systems shall be done with due regard for the safety of employees and the public during the test. Bulkheads, anchorage and bracing suitably designed to resist test pressures shall be installed if necessary. Oxygen shall not be used as a testing medium.

#### 3.16.1 Pressure Tests

Before appliances are connected, piping systems shall be filled with air or an inert gas and shall withstand a minimum pressure of 21 kPa gauge for a period of not less than 10 minutes as specified in NFPA 54 without showing any drop in pressure. Oxygen shall not be used. Pressure shall be measured with a mercury manometer, slope gauge, or an equivalent device so calibrated as to be read in increments of not greater than 1 kPa. The source of pressure shall be isolated before the pressure tests are made.

#### 3.16.2 Test With Gas

Before turning gas under pressure into any piping, all openings from which gas can escape shall be closed. Immediately after turning on the gas, the piping system shall be checked for leakage by using a laboratory-certified gas meter, an appliance orifice, a manometer, or equivalent device. All testing shall conform to the requirements of NFPA 54. If leakage is recorded, the gas supply shall be shut off, the leak shall be repaired, and the tests repeated until all leaks have been stopped.

#### 3.16.3 Purging

After testing is completed, and before connecting any appliances, all gas piping shall be fully purged. LPG piping tested using fuel gas with appliances connected does not require purging. Piping shall not be purged into the combustion chamber of an appliance. The open end of piping systems being purged shall not discharge into confined spaces or areas where there are ignition sources unless the safety precautions recommended in NFPA 54 are followed.

#### 3.16.4 Labor, Materials and Equipment

All labor, materials and equipment necessary for conducting the testing and purging shall be furnished by the Contractor.

## SECTION 15556

## FORCED HOT WATER HEATING SYSTEMS USING WATER HEAT EXCHANGERS

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designations only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 47	(1990) Ferritic Malleable Iron Castings
ASTM A 53	(1990b) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 105	(1992) Forgings, Carbon Steel, for Piping Components
ASTM A 106	(1991) Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A 183	(1983; R 1990) Carbon Steel Track Bolts and Nuts
ASTM A 193	(1992) Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A 234	(1992a) Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM A 366	(1991) Steel, Sheet, Carbon, Cold-Rolled, Commercial Quality
ASTM A 515	(1990) Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service
ASTM A 516	(1990) Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A 525	(1991b) General Requirement for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process
ASTM A 527	(1990) Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Lock-Forming Quality
ASTM A 528	(1990) Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Drawing Quality
ASTM A 536	(1984) Ductile Iron Castings

ASTM A 569	(1991a) Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip Commercial Quality
ASTM A 642	(1990) Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Drawing Quality, Special Killed
ASTM A 733	(1989) Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM B 32	(1993) Solder Metal
ASTM B 62	(1993) Composition Bronze or Ounce Metal Castings
ASTM B 75	(1992a) Seamless Copper Tube
ASTM B 88	(1993) Seamless Copper Water Tube
ASTM B 687	(1988) Brass, Copper, and Chromium-Plated Pipe Nipples
ASTM B 828	(1992) Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
ASTM D 596	(1991) Reporting Results of Analysis of Water
ASTM D 1248	(1984, R 1989) Polyethylene Plastics Molding and Extrusion Materials
ASTM D 1384	(1987) Corrosion Test for Engine Coolants in Glassware
ASTM D 2000	(1990) Rubber Products in Automotive Applications
ASTM D 3308	(1991a) PTFE Resin Skived Tape

## AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(1983; R 1992) Pipe Threads, General Purpose (Inch)
ASME B16.1	(1989) Cast Iron Pipe Flanges and Flanged Fittings
ASME B16.3	(1992) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.4	(1992) Cast Iron Threaded Fittings Classes 125 and 250
ASME B16.5	(1988; Errata; B16.5a) Pipe Flanges and Flanged Fittings

ASME B16.9	(1993) Factory-Made Wrought Steel Buttwelding Fittings
ASME B16.11	(1991) Forged Fittings, Socket-Welding and Threaded
ASME B16.15	(1985; R 1994) Cast Bronze Threaded Fittings Classes 125 and 250
ASME B16.18	(1984) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(1992) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(1989) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(1988) Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.39	(1986; R 1994) Malleable Iron Threaded Pipe Unions Classes 150, 250, and 300
ASME B16.34	(1988) Valves - Flanged, Threaded, and Welding End
ASME B31.1	(1992; B31.1a; B31.1b) Power Piping
ASME B40.1	(1991) Gauges - Pressure Indicating Dial Type - Elastic Element
ASME BPV VIII Div 1	(1992; Addenda Dec 1992, Dec 1993) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage
ASME BPV IX	(1992; Addenda Dec 1992, Dec 1993) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications

## AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C606	(1987) Grooved and Shouldered Joints
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## AMERICAN WELDING SOCIETY (AWS)

AWS A5.8	(1992) Filler Metals for Brazing and Braze Welding
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## MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(1993) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(1988) Pipe Hangers and Supports - Materials, Design and Manufacture



MSS SP-69	(1991) Pipe Hangers and Supports - Selection and Application
MSS SP-70	(1990) Cast Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(1990) Cast Iron Swing Check Valves, Flanges and Threaded Ends
MSS SP-80	(1987) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(1985) Cast Iron Globe & Angle Valves Flanged and Threaded Ends

NATIONAL ASSOCIATION OF PLUMBING-HEATING-COOLING CONTRACTORS  
(NAPHCC)

NAPHCC-01	(1993) National Standard Plumbing Code (Non-Illustrated Edition)
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NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1991) Enclosures for Electrical Equipment (1000 Volts Maximum)
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## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

### SD-01 Data

Spare Parts; FIO.

Spare parts data for each different item of material and equipment specified, after approval of the related submittals and not later than 3 months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

### Welding Procedures

Welding Procedures and Qualifications; FIO.

Six copies of qualified procedures and list of names and identification symbols of qualified welders and welding operators, prior to welding operations.

### SD-04 Drawings

Heating System; FIO.

Detail drawings consisting of a complete list of equipment and material, including manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts, and installation instructions. Drawings

shall also contain complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage of equipment and appurtenances and equipment relationship to other parts of the work including clearances for maintenance and operation.

#### SD-06 Instructions

Framed Instructions; GA.

Proposed diagrams, instructions, and other sheets, prior to posting. The instructions shall show wiring and control diagrams and complete layout of the entire system. The instructions shall include, in typed form, condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation and procedures for safely starting and stopping the system.

#### SD-09 Reports

Performance Tests; FIO.

Performance test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall indicate the final position of controls.

Water Treatment Tests; FIO.

The water quality test report shall identify the chemical composition of the heating water. The report shall include a comparison of the condition of the water with the chemical company's recommended conditions. Any required corrective action shall be documented within the report.

#### SD-13 Certificates

Bolts; FIO.

Written certification that the bolts furnished comply with the requirements of this specification, provided by the bolt manufacturer. The certification shall include illustrations of product-required markings, the date of manufacture, and the number of each type of bolt to be furnished based on this certification.

#### SD-19 Operation and Maintenance Manuals

Heating System; FIO.

Six copies of operation and six copies of maintenance manuals for the equipment furnished. One complete set, prior to performance testing and the remainder upon acceptance. Operating manuals shall detail the step-by-step procedures required for system startup, operation, and shutdown. Operating manuals shall include the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features. Maintenance manuals shall list routine maintenance procedures, water treatment procedures, possible breakdowns and repairs, and troubleshooting guides. Maintenance manuals shall include piping and equipment layout and

simplified wiring and control diagrams of the system as installed. Manuals shall be provided prior to the field training course.

### 1.3 QUALIFICATIONS

Procedures and welders shall be qualified in accordance with the code under which the welding is specified to be accomplished.

### 1.4 DELIVERY AND STORAGE

All equipment delivered and placed in storage shall be stored with protection from the weather, excessive humidity and excessive temperature variation; and dirt, dust, or other contaminants.

### 1.5 FIELD MEASUREMENTS

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

## 2 PRODUCTS

### 2.1 GENERAL MATERIAL AND EQUIPMENT REQUIREMENTS

#### 2.1.1 Standard Products

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

#### 2.1.2 Nameplates

Each major item of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

#### 2.1.3 Equipment Guards and Access

Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact shall be fully enclosed or guarded in accordance with OSHA requirements. High temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard shall be properly guarded or covered with insulation of a type specified. Catwalks, operating platforms, ladders, and guardrails shall be provided where shown and shall be constructed in accordance with Section 05500 MISCELLANEOUS METAL.

#### 2.1.4 Asbestos Prohibition

Asbestos and asbestos-containing products shall not be used.

### 2.1.5 Electrical Work

Electrical motor driven equipment specified shall be provided complete with motors, motor starters, and controls. Electric equipment (including motor efficiencies), and wiring shall be in accordance with Section 16415 ELECTRICAL WORK, INTERIOR. High efficiency motors shall be used. Electrical characteristics shall be as specified or indicated. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary for the motor control specified. Each motor shall be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Manual or automatic control and protective or signal devices required for the operation specified, and any control wiring, conduit, and connection to power required for controls and devices but not shown shall be provided.

## 2.2 PIPING, TUBING, AND FITTINGS

### 2.2.1 General

Piping, tubing, and fittings shall be as follows:

- a. Low temperature water piping shall be black steel or copper tubing with cast iron, malleable iron or steel, solder-joint, flared-tube or grooved mechanical joint fittings.
- b. Steam pipe shall be black steel with malleable iron or steel fittings.
- c. Condensate return piping shall be black steel Schedule 80 with cast iron or malleable iron, Class 250 minimum.
- d. High temperature water piping shall be black steel, Schedule 40.
- e. Vent piping shall be black steel, Schedule 40, with black malleable iron fittings.

### 2.2.2 Steel Pipe

Pipe shall conform to ASTM A 53 or ASTM A 106, Grade A or B, black steel, Schedule 40, unless otherwise specified. Steel pipe to be bent shall be ASTM A 53, Grade A, standard, or Grade B, extra strong weight. Steam pipe shall be ASTM A 53 Grade A.

### 2.2.3 Gauge Piping

Piping shall be copper tubing for low temperature water.

### 2.2.4 Copper Tubing

Tubing shall conform to ASTM B 88, Type K or L.

### 2.2.5 Malleable Iron Pipe Fittings

Fittings shall conform to ASME B16.3, type required to match adjacent piping.

#### 2.2.6 Cast Iron Pipe Fittings

Fittings shall conform to ASME B16.1 or ASME B16.4 type required to match adjacent piping.

#### 2.2.7 Steel Pipe Fittings

Fittings shall have the manufacturer's trademark affixed in accordance with MSS SP-25 so as to permanently identify the manufacturer.

##### 2.2.7.1 Welded Fittings

Welded fittings shall conform to ASTM A 234 with WPA marking. Butt welded fittings shall conform to ASME B16.9, and socket welded fittings shall conform to ASME B16.11.

##### 2.2.7.2 Grooved Mechanical Fittings

Standard fittings shall be of malleable iron conforming to ASTM A 47, Grade 32510, or ductile iron conforming to ASTM A 536, Grade 65-45-12. Fittings may also be constructed of steel, conforming to ASTM A 106, Grade B or ASTM A 53.

##### 2.2.7.3 Grooved Mechanical Pipe Joints

Pipe joints shall conform to AWWA C606. Grooved mechanical joint fittings shall be full flow factory manufactured forged steel fittings. Fittings, couplings, gaskets, and pipe grooving tool or grooved end pipe shall be products of the same manufacturer. Mechanical pipe couplings shall be of the bolted type and shall consist of a housing fabricated in two or more parts, a synthetic rubber gasket, and nuts and bolts to secure unit together. Housings shall be of malleable iron conforming to ASTM A 47, Grade 32510 or ductile iron conforming to ASTM A 536, Grade 65-45-12. Coupling nuts and bolts shall be of steel and conform to ASTM A 183. Gaskets shall be of molded synthetic rubber, Type [EPDM] [Buna-N] with central cavity, pressure responsive configuration and shall conform to ASTM D 2000.

#### 2.2.8 Fittings for Copper Tubing

Wrought copper and bronze fittings shall conform to ASME B16.22 and ASTM B 75. Cast copper alloy fittings shall conform to ASME B16.18 and ASTM B 828. Flared fittings shall conform to ASME B16.26 and ASTM B 62. Adaptors may be used for connecting tubing to flanges and threaded ends of valves and equipment. Extracted brazed tee joints produced with an acceptable tool and installed as recommended by the manufacturer may be used. Cast bronze threaded fittings shall conform to ASME B16.15.

#### 2.2.9 Steel Flanges

Flanged fittings including flanges, bolts, nuts, bolt patterns., etc. shall be in accordance with ASME B16.5 class 150 and shall have the manufacturers trademark affixed in accordance with MSS SP-25. Flange material shall conform to ASTM A 105. Flanges for high temperature water systems shall be serrated or raised-face type. Blind flange material shall conform to ASTM A 516 cold service and ASTM A 515 for hot service. Bolts shall be high strength or intermediate strength with material conforming to ASTM A 193.

#### 2.2.10 Pipe Threads

Pipe threads shall conform to ASME B1.20.1.

#### 2.2.11 Nipples

Nipples shall conform to ASTM A 733 or ASTM B 687, standard weight.

#### 2.2.12 Unions

Unions shall conform to ASME B16.39, type to match adjacent piping.

#### 2.2.13 Adapters

Adapters for copper tubing shall be brass or bronze for soldered fittings.

#### 2.2.14 Dielectric Unions

Unions shall conform to the tensile strength and dimensional requirements specified in ASME B16.39. Unions shall have metal connections on both ends to match adjacent piping. Metal parts of dielectric unions shall be separated so that the electrical current is below 1 percent of the galvanic current which would exist upon metal-to-metal contact.

#### 2.2.15 Grooved Mechanical Joints

Rigid grooved pipe joints may be provided in lieu of unions, welded, flanges or screwed piping connections at chilled water pumps and allied equipment, and on aboveground pipelines in serviceable locations, if the temperature of the circulating medium does not exceed 110 degrees C. Flexible grooved joints will not be permitted, except as vibration isolators adjacent to mechanical equipment. Rigid grooved joints shall incorporate an angle bolt pad design which maintains metal-to-metal contact with equal amount of pad offset of housings upon installation to insure positive rigid clamping of the pipe. Designs which can only clamp on the bottom of the groove or which utilize gripping teeth or jaws, or which use misaligned housing bolt holes, or which require a torque wrench or torque specifications, will not be permitted. Rigid grooved pipe couplings shall be used with grooved end pipes, fittings, valves and strainers. Rigid couplings shall be designed for not less than 862 kPa service and appropriate for static head plus the pumping head, and shall provide a water-tight joint. Grooved fittings and couplings, and grooving tools shall be provided from the same manufacturer. Segmentally welded elbows shall not be used. Grooves shall be prepared in accordance with the coupling manufacturer's latest published standards. Grooving shall be performed by qualified grooving operators having demonstrated proper grooving procedures in accordance with the tool manufacturer's recommendations. The Contracting Officer shall be notified 24 hours in advance of test to demonstrate operator's capability, and the test shall be performed at the work site, if practical, or at a site agreed upon. The operator shall demonstrate the ability to properly adjust the grooving tool, groove the pipe, and verify the groove dimensions in accordance with the coupling manufacturer's specifications.

### 2.2.16 Flexible Pipe Connectors

Flexible pipe connectors shall be designed for 1.034 MPa or 1.034 MPa service as appropriate for the static head plus the system head, and 121 degrees C. Connectors shall be installed where indicated. The flexible section shall be constructed of rubber, tetrafluoroethylene resin, or corrosion-resisting steel, bronze, monel, or galvanized steel. Materials used and the configuration shall be suitable for the pressure, vacuum, temperature, and circulating medium. The flexible section may have threaded, welded, soldered, flanged, grooved, or socket ends. Flanged assemblies shall be equipped with limit bolts to restrict maximum travel to the manufacturer's standard limits. Unless otherwise indicated, the length of the flexible connectors shall be as recommended by the manufacturer for the service intended. Internal sleeves or liners, compatible with circulating medium, shall be provided when recommended by the manufacturer. Covers to protect the bellows shall be provided where indicated.

## 2.3 MATERIALS AND ACCESSORIES

### 2.3.1 Iron and Steel Sheets

#### 2.3.1.1 Galvanized Iron and Steel

Galvanized iron and steel shall conform to ASTM A 527, ASTM A 528, or ASTM A 642, with general requirements conforming to ASTM A 525. Gauge numbers specified are Manufacturer's Standard Gauge.

#### 2.3.1.2 Uncoated (Black) Steel

Uncoated (black) steel shall conform to ASTM A 366 or ASTM A 569, composition, condition, and finish best suited to the intended use. Gauge numbers specified refer to Manufacturer's Standard Gauge.

### 2.3.2 Solder

Solder shall conform to ASTM B 32. Solder and flux shall be lead free.

### 2.3.3 Solder, Silver

Silver solder shall conform to AWS A5.8.

### 2.3.4 Thermometers

Thermometers shall have brass, malleable iron, or aluminum alloy case and frame, clear protective face, permanently stabilized glass tube with indicating-fluid column, white face, black numbers, and a 225 mm scale, and thermometers shall have rigid stems with straight, angular, or inclined pattern.

### 2.3.5 Gauges

Gauges shall conform to ASME B40.1.

### 2.3.6 Gaskets for Flanges

Composition gaskets shall conform to ASME B16.21. Gaskets shall be nonasbestos compressed material in accordance with ASME B16.21, 6.6 mm

thickness, full face or self-centering flat ring type. Gaskets shall contain aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR). NBR binder shall be used for hydrocarbon service. Gaskets shall be suitable for pressure and temperatures of piping system.

#### 2.3.7 Polyethylene Tubing

Low-density virgin polyethylene shall conform to ASTM D 1248, Type I, Category 5, Class B or C.

#### 2.3.8 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69.

### 2.4 VALVES FOR LOW TEMPERATURE WATER HEATING AND STEAM SYSTEMS

#### 2.4.1 Check Valves

Sizes 65 mm and less, bronze shall conform to MSS SP-80, Type 3 or 4, Class 125. Sizes 80 mm through 300 mm, cast iron shall conform to MSS SP-71, Type III or IV, Class 125.

#### 2.4.2 Globe Valves

Sizes 65 mm and less, bronze shall conform to MSS SP-80, Type 1, 2 or 3, Class 125. Sizes 80 mm through 300 mm, cast iron shall conform to MSS SP-85, Type III, Class 125.

#### 2.4.3 Angle Valves

Sizes 65 mm and less, bronze shall conform to MSS SP-80, Type 1, 2 or 3, Class 125. Sizes 80 mm through 300 mm, cast iron shall conform to MSS SP-85, Type III, Class 125.

#### 2.4.4 Gate Valves

Sizes 65 mm and less, bronze shall conform to MSS SP-80, Type 1 or 2, Class 125. Sizes 80 mm through 1200 mm, cast iron shall conform to MSS SP-70, Type I, Class 125, Design OT or OF (OS&Y), bronze trim.

#### 2.4.5 Air Vents

Air vents shall be provided at all piping high points in water systems, with block valve in inlet and internal check valve to allow air vent to be isolated for cleaning and inspection. Outlet connection shall be piped to nearest open site or suitable drain, or terminated 300 mm above finished grade. Pressure rating of air vent shall match pressure rating of piping system. Body and cover shall be cast iron or semi-steel with stainless steel or copper float and stainless steel or bronze internal parts. Air vents installed in piping in chase walls or other inaccessible places shall be provided with an access panel.

#### 2.4.6 Balancing Valves

Balancing valves shall have meter connections with positive shutoff valves. An integral pointer shall register degree of valve opening. Valves shall be



calibrated so that flow in liters per minute can be determined when valve opening in degrees and pressure differential across valve is known. Each balancing valve shall be constructed with internal seals to prevent leakage and shall be supplied with preformed insulation. Valves shall be suitable for 121 degrees C temperature and working pressure of the pipe in which installed. Valve bodies shall be provided with tapped openings and pipe extensions with shutoff valves outside of pipe insulation. The pipe extensions shall be provided with quick connecting hose fittings for a portable meter to measure the pressure differential. One portable differential meter shall be furnished. The meter suitable for the operating pressure specified shall be complete with hoses, vent, and shutoff valves and carrying case. In lieu of the balancing valve with integral metering connections, a ball valve or plug valve with a separately installed orifice plate or venturi tube may be used for balancing. Plug valves and ball valves 200 mm or larger shall be provided with manual gear operators with position indicators.

## 2.5 VALVES FOR HIGH AND MEDIUM TEMPERATURE WATER SYSTEMS

### 2.5.1 Check Valves

Sizes 65 mm and less, bronze shall conform to MSS SP-80, Class 300. Sizes 80 mm and less, bronze shall conform to MSS SP-80, Class 300 minimum. Sizes 80 mm through 600 mm, steel shall conform to ASME B16.34, Class 300 minimum, flanged ends, swing disc; water, oil gas or steam service to 454 degrees C.

### 2.5.2 Globe Valves

Sizes 65 mm and less, bronze shall conform to MSS SP-80, Type 1, 2 or 3, Class 300 minimum. Sizes 80 mm through 600 mm, steel shall conform to ASME B16.34, Class 300 minimum, flanged ends; water, oil, gas, or steam service to 454 degrees C.

### 2.5.3 Angle Valves

Sizes 65 mm and less, bronze shall conform to MSS SP-80, Type 1, 2 or 3, Class 300 minimum. Sizes 80 mm through 600 mm, steel shall conform to ASME B16.34, Class 300 minimum, flanged ends; water, oil, gas, or steam service to 454 degrees C.

### 2.5.4 Gate Valves

Sizes 65 mm and less, bronze shall conform to MSS SP-80, Type 1, or 2, Class 300 minimum. Sizes 80 mm through 600 mm, steel shall conform to ASME B16.34, Class 300 minimum, flanged ends; water, oil, gas or steam service to 454 degrees C. Gate shall be split wedge (double disc) type.

## 2.6 COLD WATER CONNECTIONS

Connections shall be provided which include consecutively in line a strainer, backflow prevention device, and water pressure regulator. The backflow prevention device shall be provided as indicated and in compliance with Section 15400 PLUMBING, GENERAL PURPOSE.

### 2.6.1 Strainers

Basket or Y-type strainers shall be the same size as the pipelines in which they are installed. Strainer bodies shall be rated for 862 kPa service, with bottoms drilled and plugged. Bodies shall have arrows cast on the sides to indicate the direction of flow. Each strainer shall be equipped with a removable cover and sediment basket. Basket shall not be less than 0.795 mm and shall have perforations to provide a net free area through the basket of at least four times that of the entering pipe.

### 2.6.2 Pressure Regulating Valve

Valve shall be a type that will not stick nor allow pressure to build up on the low side. Valve shall be set to maintain a terminal pressure approximately 35 kPa in excess of the static head on the system and shall operate within a 138 kPa variation regardless of initial pressure and without objectionable noise under any condition of operation.

## 2.7 EXPANSION TANK

Pressurization system shall include a replaceable diaphragm-type captive air expansion tank which will accommodate the expanded water of the system generated within the normal operating temperature range, limiting this pressure increase at all components in the system to the maximum allowable pressure at those components. The only air in the system shall be the permanent sealed-in air cushion contained in the diaphragm-type tank. Sizes shall be as indicated. Expansion tank shall be welded steel, constructed, tested and stamped in accordance with ASME BPV VIII Div 1 for a working pressure of 862 kPa and precharged to the minimum operating pressure. Tank air chamber shall be fitted with an air charging valve. Tank shall be supported by steel legs or bases for vertical installation or steel saddles for horizontal installations.

## 2.8 AIR SEPARATOR TANK

External air separation tank shall be steel, constructed, tested, and stamped in accordance with ASME BPV VIII Div 1 for a working pressure of 862 kPa. The capacity of the air separation tank indicated is minimum.

## 2.9 SYSTEM EQUIPMENT AND ACCESSORIES

### 2.9.1 Circulating Pumps

Pumps shall be as specified in Sections 11211 and 15400.

### 2.9.2 Pressure Gauges and Thermometers

Gauges shall be provided for each heat exchanger and piping as indicated. A thermometer and pressure gauge shall be provided on the high temperature water supply and return mains. Thermometers shall be separable socket type.

### 2.9.3 Vacuum Relief Valve

Vacuum relief valve shall be installed on the shell of each shell and U-tube steam heat exchanger and on the factory supplied steam inlet nozzle of each plate and frame heat exchanger. On shutoff of steam supply and condensing

of steam, the vacuum relief valve shall automatically admit air to the heat exchanger.

#### 2.9.4 Pressure Relief Valves

One or more pressure relief valves shall be provided for each heat exchanger in accordance with ASME BPV VIII Div 1. The aggregate relieving capacity of the relief valves shall be not less than that required by the above code. Discharge from the valves shall be installed as indicated. Pressure relief valves for steam heat exchangers shall be located on the low temperature water supply coming from near the heat exchanger as indicated. Relief valves for high temperature water heat exchanger shall be installed on the heat exchanger shell.

#### 2.9.5 Drains

A drain connection with 20 mm hose bib shall be installed at the lowest point in the low temperature water return main near the heat exchanger. In addition, threaded drain connections with threaded cap or plug shall be installed wherever required for thorough draining of the low temperature water system.

#### 2.9.6 Strainers

Basket or Y-type strainer-body connections shall be the same size as the pipe lines in which the connections are installed. The bodies shall have arrows clearly cast on the sides to indicate the direction of flow. Each strainer shall be equipped with an easily removable cover and sediment basket. The body or bottom opening shall be equipped with nipple and gate valve for blowdown. The basket for steam systems shall be of not less than 0.635 mm thick stainless steel, or monel with small perforations of sufficient number to provide a net free area through the basket of at least 2.5 times that of the entering pipe. The flow shall be into the basket and out through the perforations.

#### 2.10 INSULATION

Shop and field applied insulation shall be as specified in Section 15250 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

#### 2.11 FACTORY PAINTED EXPOSED SPACE HEATING EQUIPMENT

Radiator and convector enclosures shall be coated with the manufacturer's standard rust inhibiting primer for painting in the field as specified in Section 09900 PAINTING, GENERAL. All other exposed heating equipment shall be painted at the factory with the manufacturer's standard primer and enamel finish.

#### 2.12 UNIT HEATERS

Heaters shall be as specified below, and shall have a heating capacity not in excess of 125 percent of the capacity indicated.

##### 2.12.1 Propeller Fan Heaters

Heaters shall be designed for suspension and arranged for horizontal, vertical discharge of air as indicated. Casings shall be not less than

0.912 mm black steel and finished with lacquer or enamel. Suitable deflectors shall be provided to assure proper air and heat penetration capacity at floor level based on established design temperature. Suspension from heating pipes will not be permitted. Fans for vertical discharge type heaters shall operate at speeds not in excess of 1,200 rpm, except that units with 84.4 MJ output capacity or less may operate at speeds up to 1,800 rpm. Horizontal discharge type unit heaters shall have discharge or face velocities not in excess of the following:

Unit Capacity, Liters per Second	Face Velocity, Meters per Second
Up to 472	4.06
473	4.57
1417	5.08

#### 2.12.2 Centrifugal Fan Heaters

Heaters shall be arranged for floor or ceiling mounting as indicated. Heating elements and fans shall be housed in steel cabinets of sectionalized steel plates or reinforced with angle-iron frames. Cabinets shall be constructed of not lighter than 1.27 mm black steel. Each unit heater shall be provided with a means of diffusing and distributing the air. Fans shall be mounted on a common shaft, with one fan to each air outlet. Fan shaft shall be equipped with self-aligning ball, roller, or sleeve bearings and accessible means of lubrication. Fan shaft may be either directly connected to the driving motor or indirectly connected by adjustable V-belt drive rated at 150 percent of motor capacity. All fans in any one unit heater shall be the same size.

#### 2.12.3 Heating Elements

Heating coils and radiating fins shall be of suitable nonferrous alloy with threaded fittings at each end for connecting to external piping. The heating elements shall be free to expand or contract without developing leaks and shall be properly pitched for drainage. The elements shall be tested under a hydrostatic pressure of 1.38 MPa and a certified report of the test shall be submitted to the Contracting Officer. Heating coils shall be as specified in Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM for types indicated. Coils shall be suitable for use with water up to 121 degrees C.

#### 2.12.4 Motors

Motors shall be provided with NEMA 250 general purpose enclosure. Motors and motor controls shall otherwise be as specified in Section 16415 ELECTRICAL WORK, INTERIOR.

#### 2.12.5 Motor Switches

Motors shall be provided with manual selection switches with "Off," and "Automatic" positions and shall be equipped with thermal overload protection.

#### 2.12.6 Controls

Controls shall be provided as specified in Section 15950 HEATING, VENTILATING, AND AIR CONDITIONING HVAC CONTROL SYSTEMS.

#### 2.13 HEATING AND VENTILATING UNITS

Heating and ventilating units shall be as specified in Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS.

#### 2.14 WATER TREATMENT SYSTEM

##### 2.14.1 Glycol Solutions

A 20 percent concentration by volume of industrial grade ethylene glycol shall be provided. The glycol shall be tested in accordance with ASTM D 1384 with less than 0.013 mm penetration per year for all system metals. The glycol shall contain corrosion inhibitors. Silicate based inhibitors shall not be used. The solution shall be compatible with pump seals, other elements of the system, and all water treatment chemicals used within the system.

##### 2.14.2 Test Kits

All required test kits and reagents for determining the proper water conditions shall be provided.

### 3 EXECUTION

#### 3.1 INSTALLATION

All work shall be installed as indicated and in accordance with the manufacturer's diagrams and recommendations.

#### 3.2 FIELD PAINTING

Field painting of exposed pipe shall be as specified in Section 09900 PAINTING, GENERAL. Field painting of factory primed equipment shall be as specified in Section 09900 PAINTING, GENERAL.

#### 3.3 WELDING

Piping shall be welded in accordance with qualified procedures using performance qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPV IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified 24 hours in advance of tests and the tests shall be performed at the work site if practical. The welder or welding operator shall apply his assigned symbol near each weld he makes as a permanent record. Structural members shall be welded in accordance with Section 05055 WELDING, STRUCTURAL.

#### 3.4 PIPING

Unless otherwise specified, pipe and fittings installation shall conform to the requirements of ASME B31.1. Pipe shall be cut accurately to measurements established at the job site and worked into place without

springing or forcing, completely clearing all windows, doors, and other openings. Cuttings or other weakening of the building structure to facilitate piping installation will not be permitted without written approval. Pipe or tubing shall be cut square, shall have burrs removed by reaming, and shall be so installed as to permit free expansion and contraction without causing damage to building structure, pipe, joints, or hangers. Changes in direction shall be made with factory made fittings, except that bending of pipe up to 100 mm will be permitted, provided a pipe bender is used and wide sweep bends are formed. The center line radius of bends shall not be less than six diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted. Vent pipes shall be installed through the roof as indicated and shall be flashed as specified. Horizontal mains shall pitch up or down in the direction of flow as indicated. The grade shall be not less than 25 mm in 12 m. Reducing fittings shall be used for changes in pipe sizes. Open ends of pipelines and equipment shall be capped or plugged during installation to keep dirt or other foreign materials out of the systems. Pipe not otherwise specified shall be uncoated. Unions and other components for copper pipe or tubing shall be brass or bronze. Connections between ferrous and copper piping shall be electrically isolated using dielectric unions.

#### 3.4.1 Joints

Except as otherwise specified, joints used on steel pipe shall be threaded for fittings 25 mm and smaller; threaded or welded for 32 mm up through 65 mm; and flanged or welded for 80 mm and larger. Joints between sections of copper tubing or copper pipe shall be flared or sweated. Pipe and fittings 32 mm and larger installed in inaccessible conduits or trenches beneath concrete floor slabs shall be welded. Unless otherwise specified, connections to equipment shall be made with black malleable iron unions for pipe 65 mm or smaller in diameter, and with flanges for pipe 80 mm or larger in diameter.

#### 3.4.2 Low Temperature Systems

Piping may have threaded, welded, flanged or flared, sweated, or grooved mechanical joints as applicable and as specified. Reducing fittings shall be used for changes in pipe sizes. In horizontal lines, reducing fittings shall be the eccentric type to maintain the top of the adjoining pipes at the same level.

#### 3.4.3 Steam Systems

Piping may have threaded, welded, or flanged joints as applicable and as specified. Reducing fittings shall be used for changes in pipe sizes. In horizontal steam lines, reducing fittings shall be the eccentric type to maintain the bottom of the lines at the same level. Grooved mechanical joints shall not be used.

#### 3.4.4 High And Medium Temperature Systems

Temperature systems shall have welded joints to the maximum extent practicable, except screwed joints and fittings may be used at connections to equipment and on piping 65 mm and smaller. Equipment connections 80 mm and larger shall be flanged. Piping connections 80 mm and larger may be welded or flanged. In horizontal lines, reducing fittings shall be the

eccentric type to maintain the tops of adjoining pipes at the same level. Grooved mechanical joints shall not be used.

#### 3.4.5 Threaded Joints

Threaded joints shall be made with tapered threads properly cut, and shall be made tight with PTFE tape complying with ASTM D 3308, or equivalent thread joint compound applied to the male threads only, and in no case to the fittings.

#### 3.4.6 Welded Joints

Joints shall be fusion-welded unless otherwise required. Changes in direction of piping shall be made with welding fittings only. Branch connection may be made with either welding tees or branch outlet fittings. Branch outlet fittings shall be forged, flared for improvement of flow where attached to the run, and reinforced against external strains.

#### 3.4.7 Flanged Joints or Unions

Flanged joints or unions shall be provided in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control valves, and similar items. Flanged joints shall be faced true, provided with gaskets, and made square and tight. Full-faced gaskets shall be used with cast iron flanges.

#### 3.4.8 Flared and Sweated Pipe and Tubing

Pipe and tubing shall be cut square and burrs shall be removed. Both inside of fittings and outside of tubing shall be cleaned with an abrasive before sweating. Care shall be taken to prevent annealing of fittings and hard drawn tubing when making connection. Installation shall be made in accordance with the manufacturer's recommendations. Changes in direction of piping shall be made with flared or soldered fittings only. Solder and flux shall be lead free. Joints for soldered fittings shall be made with silver solder or 95:5 tin-antimony solder. Cored solder shall not be used. Joints for flared fittings shall be of the compression pattern. Swing joints or offsets shall be provided on all branch connections, mains, and risers to provide for expansion and contraction forces without undue stress to the fittings or to short lengths of pipe or tubing.

#### 3.4.9 Mechanical Tee Joint

An extracted mechanical tee joint may be made in copper tube. Joint shall be produced with an appropriate tool by drilling a pilot hole and drawing out the tube surface to form a collar having a minimum height of three times the thickness of the tube wall. To prevent the branch tube from being inserted beyond the depth of the extracted joint, dimpled depth stops shall be provided. The branch tube shall be notched for proper penetration into fitting to assure a free flow joint. Joints shall be brazed in accordance with NAPHCC-01. Soldered joints will not be permitted.

### 3.5 CONNECTIONS TO EQUIPMENT

Supply and return connections shall be provided by the Contractor unless otherwise indicated. Valves and traps shall be installed in accordance with the manufacturer's recommendations. Unless otherwise indicated, the size of

the supply and return pipes to each piece of equipment shall be not smaller than the connections on the equipment. No bushed connections shall be permitted. Change in sizes shall be made with reducers or increasers only.

#### 3.5.1 Low Temperature Water Connections

Connections, unless otherwise indicated, shall be made with malleable iron unions for piping 65 mm or less in diameter and with flanges for pipe 80 mm or more in diameter.

#### 3.5.2 Medium Temperature Water Connections

Connections shall be made with 13.8 MPa black malleable iron unions for pipe 20 mm or less in diameter and with flanges for pipe 25 mm and larger in diameter.

### 3.6 BRANCH CONNECTIONS

Branches shall pitch up or down as indicated, unless otherwise specified. Connection shall be made to insure unrestricted circulation, eliminate air pockets, and permit drainage of the system.

#### 3.6.1 Low Temperature Water Branches

Branches taken from mains shall pitch with a grade of not less than 25 mm in 3 m.

#### 3.6.2 Medium Temperature Water Branches

Branches shall take off at 45 degrees in the direction of the fluid flow from the supply and return lines and should be branched from the top or upper half of the main line unless otherwise indicated. Abrupt reduction in pipe sizes shall be avoided.

### 3.7 RISERS

The location of risers is approximate. Exact locations of the risers shall be as approved.

### 3.8 SUPPORTS

#### 3.8.1 General

Hangers used to support piping 50 mm and larger shall be fabricated to permit adequate adjustment after erection while supporting the load. Pipe guides and anchors shall be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. All piping subjected to vertical movement when operating temperatures exceed ambient temperatures, shall be supported by variable spring hangers and supports or by constant support hangers.

##### 3.8.1.1 Seismic Requirements for Pipe Supports, Standard Bracing

All piping and attached valves shall be supported and braced to resist seismic loads as specified under Section 13080 SEISMIC PROTECTION FOR MECHANICAL, ELECTRICAL EQUIPMENT. Structural steel required for reinforcement to properly support piping, headers, and equipment but not



shown shall be provided under this section. Material used for supports shall be as specified under Section 05120 STRUCTURAL STEEL.

#### 3.8.1.2 Structural Attachments

Structural steel brackets required to support piping, headers, and equipment, but not shown, shall be provided under this section. Material and installation shall be as specified under Section 05120 STRUCTURAL STEEL. Pipe hanger loads suspended from steel joist panel points shall not exceed 222 N. Loads exceeding 222 N shall be suspended from panel points.

#### 3.8.1.3 Multiple Pipe Runs

In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for any individual pipe in the multiple pipe run.

#### 3.8.2 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts and supports shall conform to MSS SP-58 and MSS SP-69, except as specified as follows:

- a. Types 5, 12, and 26 shall not be used.
- b. Type 3 shall not be used on insulated pipe which has a vapor barrier. Type 3 may be used on insulated pipe that does not have a vapor barrier if clamped directly to the pipe and if the clamp bottom does not extend through the insulation and the top clamp attachment does not contact the insulation during pipe movement.
- c. Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for Type 18 inserts.
- d. Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.
- e. Type 20 attachments used on angles and channels shall be furnished with an added malleable iron heel plate or adapter.
- f. Type 24 may be used only on trapeze hanger systems or on fabricated frames.
- g. Where Type 39 saddle or Type 40 shield are permitted for a particular pipe attachment application, the Type 39 saddle shall be used on all pipe 100 mm and larger.
- h. Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 300 mm from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 1.5 m apart at valves.

- i. Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 4.5 m, except that pipe shall be supported not more than 2.4 m from end of risers, and at vent terminations.
- j. Type 35 guides using steel, reinforced PTFE or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions and bearing loads encountered. Where steel slides do not require provision for restraint or lateral movement, an alternate guide method may be used. On piping 100 mm and larger, a Type 39 saddle may be welded to the pipe and freely rest on a steel plate. On piping under 100 mm, a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate. Where there are high system temperatures and welding to piping is not desirable, then the Type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 100 mm, or by an amount adequate for the insulation, which ever is greater.
- k. Except for Type 3, pipe hangers on horizontal insulated pipe shall be the size of the outside diameter of the insulation.

### 3.8.3 Piping in Trenches

Piping shall be supported as indicated.

## 3.9 PIPE SLEEVES

### 3.9.1 Pipe Passing Through Concrete or Masonry

Pipe passing through concrete or masonry walls or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves shall not be installed in structural members except where indicated or approved. Rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective wall, floor, or roof, and shall be cut flush with each surface. Unless otherwise indicated, sleeves shall provide a minimum of 6 mm annular space between bare pipe or insulation surface and sleeves. Sleeves in bearing walls, waterproofing membrane floors, and wet areas shall be steel pipe or cast iron pipe. Sleeves in nonbearing walls, floors, or ceilings may be steel pipe, cast iron pipe, or galvanized sheet metal with lock-type longitudinal seam and of the metal thickness indicated. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over insulation and sleeve in nonfire rated walls and floors shall be sealed as indicated and specified in Section 07920 JOINT SEALING. Penetrations in fire walls and floors shall be sealed in accordance with Section 07270 FIRESTOPPING.

### 3.9.2 Pipes Passing Through Waterproofing Membranes

Pipes passing through waterproofing membranes shall be installed through a 19.5 kg/square meter lead-flashing sleeve, a 4.9 kg/square meter copper sleeve, or a 0.813 mm thick aluminum sleeve, each having an integral skirt or flange. Flashing sleeve shall be suitably formed, and the skirt or flange shall extend 200 mm or more from the pipe and shall be set over the

roof or floor membrane in a troweled coating of bituminous cement. The flashing sleeve shall extend up the pipe a minimum of 50 mm above the highest flood level of the roof or a minimum of 250 mm above the roof, whichever is greater, or 250 mm above the floor. The annular space between the flashing sleeve and the bare pipe or between the flashing sleeve and the metal-jacket-covered insulation shall be sealed as indicated. At the Contractor's option, pipes up to and including 250 mm in diameter passing through roof or floor waterproofing membrane may be installed through a cast iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Waterproofing membrane shall be clamped into place and sealant shall be placed in the caulking recess.

### 3.9.3 Mechanical Seal Assembly

In lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve or conduit and sleeve, a modular mechanical type sealing assembly may be installed. The seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates. The links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolts shall cause the rubber sealing elements to expand and provide a watertight seal between the pipe/conduit and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe/conduit and sleeve involved. The Contractor electing to use the modular mechanical type seals shall provide sleeves of the proper diameters.

### 3.9.4 Counterflashing Alternate

As an alternate to caulking and sealing the annular space between the pipe and flashing sleeve or metal-jacket-covered insulation and flashing sleeve, counterflashing may be by standard roof coupling for threaded pipe up to 150 mm in diameter; lead-flashing sleeve for dry vents and turning the sleeve down into the pipe to form a waterproof joint; or tack-welded or banded-metal rain shield round the pipe and sealing as indicated.

### 3.9.5 Waterproofing Clamping Flange

Pipe passing through wall waterproofing membrane shall be sleeved as specified. In addition, a waterproofing clamping flange shall be installed as indicated.

### 3.9.6 Fire Seal

Where pipes pass through fire walls, fire partitions, fire rated pipe chase walls or floors above grade, a fire seal shall be provided as specified in Section 07270 FIRESTOPPING.

### 3.9.7 Escutcheons

Escutcheons shall be provided at all finished surfaces where exposed piping, bare or covered, passes through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Escutcheons shall be fastened securely to pipe sleeves or to extensions of sleeves without any part of sleeves being visible. Where sleeves project slightly from floors, special deep-

type escutcheons shall be used. Escutcheons shall be chromium-plated iron or chromium-plated brass, either one-piece or split pattern, held in place by internal spring tension or setscrew.

### 3.10 ANCHORS

Anchors shall be provided where necessary or indicated to localize expansion or prevent undue strain on piping. Anchors shall consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Anchor braces shall be installed using turnbuckles where required. Supports, anchors, or stays shall not be attached in places where construction will be damaged by installation operations or by the weight or expansion of the pipeline.

### 3.11 PIPE EXPANSION

The expansion of supply and return pipes shall be provided for by changes in the direction of the run of pipe, by expansion loops, or by expansion joints as indicated. Low temperature water and steam expansion joints may be one of the types specified.

#### 3.11.1 Expansion Loops

Expansion loops shall provide adequate expansion of the main straight runs of the system within the stress limits specified in ASME B31.1. The loops shall be cold-sprung and installed where indicated. Pipe guides shall be provided as indicated.

### 3.12 VALVES AND EQUIPMENT ACCESSORIES

#### 3.12.1 Valves and Equipment

Valves shall be installed at the locations shown or specified, and where required for the proper functioning of the system as directed. Gate valves shall be used unless otherwise indicated, specified, or directed. Valves shall be installed with their stems horizontal to or above the main body of the valve. Valves used with ferrous piping shall have threaded or flanged ends and sweat-type connections for copper tubing.

#### 3.12.2 Gravity Flow-Control Valve

The valve to control the flow of water shall be installed in the supply main near the heat exchanger. The valve shall operate so that when the circulating pump starts, the increased pressure within the main will open the valve; when the pump stops, the valve will close. The valve shall be constructed with a cast iron body and shall be provided with a device whereby the valve can be opened manually to allow gravity circulation. The flow-control valve shall be designed for the intended purpose, and shall be installed as recommended by the manufacturer.

#### 3.12.3 Thermometer Socket

A thermometer well shall be provided in each return line for each circuit in multicircuit systems.

#### 3.12.4 Air Vents

Vents shall be installed where indicated, and on all high points and piping offsets where air can collect or pocket.

##### 3.12.4.1 Water Air Vents

[High] [Medium] temperature water air vents shall be as indicated. Vent discharge lines shall be double-valved with globe valves and shall discharge into a funnel drain.

#### 3.13 UNIT HEATERS

Unit heaters shall be installed as indicated and in accordance with the manufacturer's instructions.

#### 3.14 INSULATION

Thickness of insulation materials for piping and equipment and application shall be in accordance with Section 15250 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

#### 3.15 TESTING AND CLEANING

##### 3.15.1 Pressure Testing

The Contractor shall notify the Contracting Officer 15 days before the tests are to be conducted. The tests shall be performed in the presence of the Contracting Officer. The Contractor shall furnish all instruments and personnel required for the tests. Electricity, steam, and water will be furnished by the Government. All test results shall be accepted before thermal insulation is installed. The entire low temperature heating system, including heat exchanger, radiators and fittings, shall be hydrostatically tested and proved tight under a pressure of 310 kPa for a period of four hours.

##### 3.15.2 Cleaning

After the hydrostatic tests have been made and prior to the operating tests, the heat exchanger and piping shall be thoroughly cleaned by filling the system with a solution of 0.5 kg of caustic soda or 0.5 kg of trisodium phosphate per 200 L of water. Observe the proper safety precautions in the handling and use of these chemicals. The water shall be heated to approximately 66 degrees C, and the solution circulated in the system for a period of 48 hours, then drained and the system thoroughly flushed out with fresh water. Equipment shall be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. The Contractor shall be responsible for maintaining the system in a clean condition until final acceptance. Bearings shall be lubricated with oil or grease as recommended by the manufacturer.

## 3.15.3 Water Treatment Testing

## 3.15.3.1 Water Quality Test

The heating water shall be analyzed prior to the acceptance of the facility by the water treatment company. The analysis shall include the following information recorded in accordance with ASTM D 596.

Date of Sample	[_____]
Temperature	[_____] degrees [F] [C]
Silica (SiO <sub>2</sub> )	[_____] ppm (mg/l)
Insoluble	[_____] ppm (mg/l)
Iron and Aluminum Oxides	[_____] ppm (mg/l)
Calcium (Ca)	[_____] ppm (mg/l)
Magnesium (Mg)	[_____] ppm (mg/l)
Sodium and Potassium (Na and K)	[_____] ppm (mg/l)
Carbonate (HCO <sub>3</sub> )	[_____] ppm (mg/l)
Sulfate (SO <sub>4</sub> )	[_____] ppm (mg/l)
Chloride (Cl)	[_____] ppm (mg/l)
Nitrate (NO <sub>3</sub> )	[_____] ppm (mg/l)
Turbidity	[_____] unit
pH	[_____]
Residual Chlorine	[_____] ppm (mg/l)
Total Alkalinity	[_____] ppm (meq/l)
Noncarbonate Hardness	[_____] ppm (meq/l)
Total Hardness	[_____] ppm (meq/l)
Dissolved Solids	[_____] ppm (mg/l)
Fluorine	[_____] ppm (mg/l)
Conductivity	[_____] microsiemens/cm

## 3.16 TESTING, ADJUSTING AND BALANCING

Except as specified herein, testing, adjusting, and balancing shall be in accordance with Section 15990 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

## 3.17 MANUFACTURER'S SERVICES

Services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified shall be provided. The representative shall supervise the installation, adjustment, and testing of the equipment.

## 3.18 FRAMED INSTRUCTIONS

Framed instructions containing wiring and control diagrams under glass or in laminated plastic shall be posted where directed. Condensed operating instructions, prepared in typed form, shall be framed as specified above and posted beside the diagrams. The framed instructions shall be posted before acceptance testing of the system.

### 3.19 FIELD TRAINING

A field training course shall be provided for designated operating and maintenance staff members. Training shall be provided for a total period of 8 hours of normal working time and shall start after the system is functionally complete but prior to final acceptance tests. Field training shall cover all of the items contained in the operating and maintenance manuals.



US Army Corps  
of Engineers  
Tulsa District

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Fort Sill, Oklahoma

# **Whole Barracks Complex Renewal**

## **Project Specifications Volume V of V**

October 1998

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## SECTION 15569

WATER AND STEAM HEATING; OIL, GAS OR BOTH; UP TO 20 MBTUH

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)

AMCA 801 (1992) Industrial Process/Power Generation Fans: Specification Guidelines

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.13 (1991; Z21.13a; Z21.13b) Gas-Fired Low-Pressure Steam and Hot Water Boilers

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 47 (1990) Ferritic Malleable Iron Castings

ASTM A 53 (1995a) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

ASTM A 105 (1997) Forgings, Carbon Steel, for Piping Components

ASTM A 106 (1994) Seamless Carbon Steel Pipe for High-Temperature Service

ASTM A 167 (1996) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

ASTM A 183 (1983, R 1990) Carbon Steel Track Bolts and Nuts

ASTM A 193 (1996) Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service

ASTM A 234 (1996) Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures

ASTM A 366 (1991; R 1993) Steel, Sheet, Carbon, Cold-Rolled, Commercial Quality

ASTM A 515 (1992) Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service

ASTM A 516	(1990) Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A 536	(1984; R 1993) Ductile Iron Castings
ASTM A 653	(1995) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B 32	(1995a) Solder Metal
ASTM B 62	(1993) Composition Bronze or Ounce Metal Castings
ASTM B 75	(1993) Seamless Copper Tube
ASTM B 88	(1996) Seamless Copper Water Tube
ASTM B 813	(1993) Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube
ASTM B 828	(1992) Making Capillary Joints by Soldering of Copper and Copper-Alloy Tube and Fittings
ASTM C 27	(1993) Fireclay and High-Alumina Refractory Brick
ASTM C 34	(1993) Structural Clay Load-Bearing Wall Tile
ASTM C 155	(1988; R 1992) Classification of Insulating Firebrick
ASTM C 401	(1991) Alumina and Alumina Silicate Castable Refractories
ASTM D 596	(1991) Reporting Results of Analysis of Water
ASTM D 2000	(1990; R 1994) Rubber Products in Automotive Applications
ASTM F 872	(1984; R 1990) Filter Units, Air Conditioning: Viscous-Impingement Type, Cleanable
ASTM F 1097	(1991) Mortar, Refractory (High-Temperature, Air-Setting)

## AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(1983; R 1992) Pipe Threads, General Purpose (Inch)
ASME B16.3	(1992) Malleable Iron Threaded Fittings
ASME B16.4	(1992) Gray Iron Threaded Fittings

ASME B16.5	(1988; Errata Oct 88; B16.5a) Pipe Flanges and Flanged Fittings
ASME B16.9	(1993) Factory-Made Wrought Steel Buttwelding Fittings
ASME B16.11	(1991) Forged Fittings, Socket-Welding and Threaded
ASME B16.15	(1985; R 1994) Cast Bronze Threaded Fittings Classes 125 and 250
ASME B16.18	(1984; R 1994) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(1992) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(1989) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(1988) Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.34	(1988) Valves - Flanged, Threaded and Welding End
ASME B16.39	(1986; R 1994) Malleable Iron Threaded Pipe Unions Classes 150, 250, and 300
ASME B19.3	(1991; B19.3a; B19.3b) Safety Standard for Compressors for Process Industries
ASME B31.1	(1995) Power Piping
ASME B31.5	(1992; B31.5a) Refrigeration Piping
ASME B40.1	(1991) Gauges - Pressure Indicating Dial Type - Elastic Element
ASME BPV IV	(1995; Addenda Dec 1995) Boiler and Pressure Vessel Code; Section IV, Heating Boilers
ASME BPV VIII Div 1	(1995; Addenda Dec 1995) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage
ASME BPV IX	(1995; Addenda Dec 1995) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications
ASME CSD-1	(1992; CSD-1a; CSD-1b) Controls and Safety Devices for Automatically Fired Boilers

## AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C606	(1987) Grooved and Shouldered Joints
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## AMERICAN WELDING SOCIETY (AWS)

AWS A5.8 (1992) Filler Metals for Brazing and Braze Welding

AWS B2.2 (1991) Brazing Procedure and Performance Qualification

## COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA 404/0 RR (1993) Copper Tube for Plumbing, Heating, Air Conditioning and Refrigeration

## HYDRONICS INSTITUTE (HYI)

HYI-01 (1996) I=B=R Ratings for Boilers, Baseboard Radiation and Finned Tube (Commercial) Radiation

## MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25 (1993) Standard Marking System for Valves, Fittings, Flanges and Unions

MSS SP-58 (1993) Pipe Hangers and Supports - Materials, Design and Manufacture

MSS SP-69 (1996) Pipe Hangers and Supports - Selection and Application

MSS SP-70 (1990) Cast Iron Gate Valves, Flanged and Threaded Ends

MSS SP-71 (1990) Cast Iron Swing Check Valves, Flanges and Threaded Ends

MSS SP-72 (1992) Ball Valves with Flanged or Butt-welding Ends for General Service

MSS SP-73 (1991) Brazing Joints for Copper and Copper Alloy Pressure Fittings

MSS SP-78 (1987; R 1992) Cast Iron Plug Valves, Flanged and Threaded Ends

MSS SP-80 (1987) Bronze Gate, Globe, Angle and Check Valves

MSS SP-85 (1994) Cast Iron Globe & Angle Valves, Flanged and Threaded Ends

MSS SP-110 (1992) Ball Valves Threaded, Socket Welding, Solder Joint, Grooved and Flared Ends

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(1992) National Fuel Gas Code
NFPA 70	(1996) National Electrical Code
NFPA 85C	(1991) Prevention of Furnace Explosions/Implosions in Multiple Burner Boiler-Furnaces
NFPA 211	(1992) Chimneys, Fireplaces, Vents and Solid Fuel-Burning Appliances
NFPA 8501	(1992) Single Burner Boiler Operations

## UNDERWRITERS LABORATORIES (UL)

UL-06	(1996) Gas and Oil Equipment Directory
UL 795	(1994; Rev Jan 1996) Commercial-Industrial Gas Heating Equipment

## 1.2 GENERAL REQUIREMENTS

## 1.2.1 Standard Products

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

## 1.2.2 Asbestos Prohibition

Asbestos and asbestos-containing products shall not be used.

## 1.2.3 Nameplates

Each major component of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the equipment. Each pressure vessel shall have an approved ASME stamp.

## 1.2.4 Equipment Guards

Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact shall be fully enclosed or guarded in accordance with OSHA requirements. High temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard shall be properly guarded or covered with insulation of a type specified. Catwalks, operating platforms, ladders, and guardrails shall be provided where shown and shall be constructed in accordance with Section 05500 MISCELLANEOUS METAL.

### 1.2.5 Verification of Dimensions

The Contractor shall become familiar with details of the work, verify dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work or ordering any materials.

### 1.2.6 Welding

Boilers and piping shall be welded and brazed in accordance with qualified procedures using performance-qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPV IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified 24 hours in advance of tests, and the tests shall be performed at the work site if practical. The welder or welding operator shall apply his assigned symbol near each weld he makes as a permanent record. Structural members shall be welded in accordance with Section 05055 WELDING, STRUCTURAL.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

#### SD-01 Data

Manufacturer's Catalog Data; GA.

Manufacturer's catalog data shall be included with the detail drawings for the following items:

- Boilers
- Fuel Burning Equipment
- Combustion Control Equipment
- Pumps
- Fittings and Accessories
- Water Treatment System

The data shall show model, size, options, etc., that are intended for consideration. Data submitted shall be adequate to demonstrate compliance with contract requirements.

Spare Parts Data; FIO.

Spare parts data for each different item of material and equipment, after approval of the detail drawings and no later than 2 months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply, and a list of the parts recommended by the manufacturer to be replaced after 1 and 3 years of service.

Water Treatment Plan; GA.

Six complete copies of the proposed water treatment plan. The plan shall include a layout, control scheme, a list of the existing water conditions including the items listed in paragraph BOILER WATER TREATMENT, a list of

all chemicals, the proportion of chemicals to be added, the final treated water conditions, and a description of environmental concerns for handling the chemicals.

Heating and Fuel Systems Test Procedures; GA.

Proposed test procedures for the heating system tests and fuel system tests, at least 2 weeks prior to the start of related testing.

Welding Procedures; FIO.

A copy of qualified welding procedures, at least 2 weeks prior to the start of welding operations.

Qualification; FIO.

A statement from the firms proposed to prepare submittals and perform installation and testing, demonstrating successful completion of similar services of at least five projects of similar size or scope, at least 2 weeks prior to the submittal of any other item required by this section.

Welding Qualification; FIO.

A list of names and identification symbols of qualified welders and welding operators, at least 2 weeks prior to the start of welding operations.

#### SD-04 Drawings

Heating System; GA.

Detail drawings consisting of equipment layout including installation details and electrical connection diagrams; combustion and safety control diagrams; ductwork layout showing the location of supports and hangers, typical hanger details, gauge reinforcement, reinforcement spacing rigidity classification, and static pressure and seal classifications; and piping layout showing the location of guides and anchors, the load imposed on each support or anchor, and typical support details. Drawings shall include any information required to demonstrate that the system has been coordinated and will properly function as a unit and shall show equipment relationship to other parts of the work, including clearances required for operation and maintenance.

#### SD-06 Instructions

Posted Instructions; GA.

System layout diagrams that show the layout of equipment, piping, and ductwork and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system, framed under glass or laminated plastic, at least 2 weeks prior to the start of related testing. After approval, these items shall be posted where directed.

## SD-07 Schedules

Tests; GA.

Proposed test schedules for the heating system and fuel system tests, at least 2 weeks prior to the start of related testing.

## SD-09 Reports

Heating System and Fuel System Tests; FIO.

Test reports for the heating system tests and the fuel system test, upon completion of testing complete with results.

Water Treatment Tests; GA.

(1) The water quality test report shall identify the chemical composition of the boiler water. The report shall include a comparison of the condition of the boiler water with the manufacturer's recommended conditions. Any required corrective action shall be documented within the report.

(2) A test report shall identify the condition of the boiler at the completion of 1 year of service. The report shall include a comparison of the condition of the boiler with the manufacturer's recommended operating conditions.

## SD-13 Certificates

Bolts; FIO.

Written certification by the bolt manufacturer that the bolts furnished comply with the requirements of this specification. The certification shall include illustrations of product markings, the date of manufacture, and the number of each type of bolt to be furnished based on this certification.

Boiler Emissions; FIO.

Written certification by the boiler manufacturer that each boiler furnished complies with Federal, state, and local regulations for emissions. The certification shall also include a description of applicable emission regulations. If any boiler is exempt from the emission regulations, the certification shall indicate the reason for the exemption.

## SD-19 Operation and Maintenance Manuals

Heating System; GA.

Six complete manuals listing step-by-step procedures required for system startup, operation, shutdown, and routine maintenance, at least 2 weeks prior to field training. The manuals shall include the manufacturer's name, model number, parts list, simplified wiring and control diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. Each service organization shall be capable of providing 4 hour onsite response to a service call on an emergency basis.



Water Treatment System; GA.

Six complete copies of operating and maintenance manuals for the step-by-step water treatment procedures, including procedures for testing the water quality.

#### 1.4 MANUFACTURER'S SERVICES

Services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified shall be provided. The representative shall supervise the installing, adjusting, and testing of the equipment.

#### 1.5 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be protected from the weather, humidity and temperature variations, dirt and dust, and other contaminants.

### 2 PRODUCTS

#### 2.1 BOILERS

Each boiler shall have the output capacity in kilowatts (kW) as indicated when fired with the specified fuels. The boiler shall be furnished complete with the gas burning equipment, boiler fittings and trim, automatic controls, forced draft fan, electrical wiring, insulation, piping connections, and protective jacket. The boiler shall be completely assembled and tested at the manufacturer's plant. Boiler auxiliaries including fans, motors, drives, and similar equipment shall be provided with at least 10 percent excess capacity to allow for field variations in settings and to compensate for any unforeseen increases in pressure losses in appurtenant piping and ductwork. However, the boiler safety devices shall not be sized for a 10 percent excess capacity. The boiler and its accessories shall be designed and installed to permit ready accessibility for operation, maintenance, and service. Boilers shall be designed, constructed, and equipped in accordance with ASME BPV IV. Each boiler shall be of the watertube type and designed for water service as specified herein. The boiler capacity shall be based on the ratings shown in HYI-01 or as certified by the American Boiler Manufacturers Association, or American Gas Association.

##### 2.1.1 Watertube Boiler

Boiler shall be self-contained, packaged type, complete with all accessories, mounted on a structural steel base. The heat input rate for finned tube designs shall not be greater than 38 Kw per square meter based on internal heater area. The heat input rate for other boilers shall not be greater than 12 Kw per square meter of fireside heating surface.

##### 2.1.2 Hot Water Heating Boilers

The hot water heating boiler shall be capable of operating at the specified maximum continuous capacity without damage or deterioration to the boiler, its setting, firing equipment, or auxiliaries. The rated capacity shall be the capacity at which the boiler will operate continuously while maintaining

at least the specified minimum efficiency. The boiler design conditions shall be as follows:

- a. Boiler design pressure 861.9 kPa.
- b. Max. heating hot water system operating pressure 413.7 kPa.
- c. Hot water temperature 87.78 degrees C.
- d. Approximate nominal temperature differential between boiler discharge and system return 11.11 degrees C.
- e. Max allowable water pressure drop through the boiler heat exchanger shall be 35 kPa.
- f. Outdoor ambient air temperature 48.9 degrees C (max), -17.78 degrees C (min).
- g. Site elevation 312.5 m Above Mean Sea Level (AMSL).
- h. Required maximum continuous capacity shall be as shown on the project documents.
- i. Rated capacity, see h above.
- j. Maximum exhaust stack temperature 204.4 degrees C.
- k. Gas fired boilers with a capacity of greater than or equal to 90 kW shall have a combustion efficiency of at least 80 percent when fired at the maximum and minimum ratings allowed by the controls.

## 2.2 FUEL BURNING EQUIPMENT

Boiler shall be designed to burn natural gas. Each boiler shall comply with Federal, state, and local emission regulations.

### 2.2.1 Burners

#### 2.2.1.1 Gas Fired Burners and Controls

Burners shall be UL approved mechanical draft burners with all air necessary for combustion supplied by a blower where the operation is coordinated with the burner. Burner shall be provided complete with fuel supply system in conformance with the following safety codes or standards:

- a. Gas-fired units with inputs greater than 1.17 MW per combustion chamber shall conform to UL 795. Gas fired units less than 3.66 MW input shall conform to ANSI Z21.13. Single burner gas-fired units greater than or equal to 3.66 MW input shall conform to NFPA 8501. Multiple burner gas-fired units greater than or equal to 3.66 MW input shall conform to NFPA 85C.

### 2.2.2 Draft Fans

Fans conforming to AMCA 801 forced-draft shall be furnished as an integral part of boiler design. Fans shall be centrifugal with backward-curved blades or radial-tip blades or axial flow type. Each fan shall be sized for

output volume and static pressure rating sufficient for pressure losses, excess air requirements at the burner, leakages, temperature, and elevation corrections for worst ambient conditions, all at full combustion to meet net-rated output at normal firing conditions, plus an overall excess air volume of 10 percent against a 20 percent static overpressure. Noise levels for fans shall not exceed 85 decibels in any octave band at a .914 meters station. Forced draft fan bearings shall be air cooled.

#### 2.2.2.1 Draft Fan Control

Forced-draft centrifugal fans shall have inlet vane controls or shall have variable speed control where indicated. Inlet vanes shall be suitable for use with combustion control equipment. Axial propeller fans shall have variable propeller pitch control.

#### 2.2.2.2 Draft Fan Drives

Fans shall be driven by electric motors. Electric motor shall be drip proof, suitable for installation in a Class II, Division 1, Group F, hazardous location conforming to NFPA 70. Motor starter shall be magnetic across-the-line or reduced voltage start type with general purpose enclosure and shall be furnished with four auxiliary interlock contacts.

#### 2.2.3 Draft Damper

Boilers shall be provided with automatic dampers, draft hoods, or barometric dampers as recommended by the boiler manufacturer to maintain proper draft in the boiler. Draft damper shall be provided in a convenient and accessible location in the flue gas outlet from the boiler. Automatic damper shall be arranged for automatic operation by means of a furnace draft regulator.

### 2.3 COMBUSTION CONTROL EQUIPMENT

Combustion control equipment shall be provided as a system by a single manufacturer. Field installed automatic combustion control system shall be installed in accordance with the manufacturer's recommendations and under the direct supervision of a representative of the control manufacturer. The boiler water temperature shall be controlled by a water temperature controller. The equipment shall operate either electrically or pneumatically. On multiple boiler installations, each boiler unit shall have a completely independent system of controls responding to the load and to a plant master controller. If recording instruments are provided, a 1 year supply of ink and 400 blank charts for each recorder shall be furnished.

#### 2.3.1 Pneumatic Controls

If pneumatic operation is provided, a regenerant desiccant air dryer unit shall be provided. Boiler shall shut down on loss of control air pressure. Pneumatic control systems shall conform to ASME B19.3. Air filter regulator sets shall be installed at each control valve and transmitter in the system. The master air filter regulator set on the control panel shall be the dual type where one side can be cleaned and repaired while the other is operating. Exterior control air piping and devices shall be protected from freezing.

### 2.3.2 Electrical controls

Electrical control devices shall be rated at 120 volts and shall be connected as specified in Section 16415 ELECTRICAL WORK, INTERIOR.

### 2.3.3 Water Temperature Controller

The controller shall be of sturdy construction and shall be protected against dust and dampness. The thermostatic element shall be inserted in a separable socket installed in the upper part of the boiler near the water outlet. Modulating controllers shall control the fuel burning equipment to maintain set boiler water temperature within 2 percent.

### 2.3.4 Boiler Combustion Controls and Positioners

- a. Gas boiler units shall be provided with modulating combustion controls with gas pilot or spark ignition. Modulating controls shall be provided with a means for manually controlling the firing rate.
- b. Modulating control function shall be accomplished using positioning type controls. Air flow ratio and fuel control valve shall be controlled by relative positions of operative levers on a jackshaft responding to a water temperature controller. Positioning type combustion control equipment shall include draft controls with synchronized fuel feed and combustion air supply controls, while and shall maintain the proper air/fuel ratio. The desired furnace draft shall be maintained within 0.01 inch of water column.

### 2.3.5 Combustion Safety Controls and Equipment

Combustion safety controls and equipment shall be UL listed, microprocessor-based distributed process controller. The system shall include mounting hardware, wiring and cables, and associated equipment. The controller shall be mounted completely wired, programmed, debugged, and tested to perform all of its functions. The controller shall process the signals for complete control and monitoring of the boiler. This shall include maintaining boiler status, starting and stopping all control functions, sequencing control functions and signaling alarm conditions. The program shall be documented and include cross references in description of coils and contacts. Microprocessor shall be able to perform self diagnostics and contain a message center to provide operator with status and failure mode information. Controllers for each boiler shall be mounted on a separate, free standing panel adjacent to the boiler or for packaged boilers on the boiler supporting structure. Control systems and safety devices for automatically fired boilers shall conform to ASME CSD-1. Electrical combustion and safety controls shall be rated at 120 volts, single phase, 60 Hz and shall be connected as specified in Section 16415 ELECTRICAL WORK, INTERIOR. A 100 mm diameter alarm bell shall be provided and shall be located where indicated or directed. The alarm bell shall ring when the boiler is shut down by any safety control or interlock. Indicating lights shall be provided on the control panel. A red light shall indicate flame failure, and a green light shall indicate that the main fuel valve is open. The following shutdown conditions shall require a manual reset before the boiler can automatically recycle:

- a. Flame failure.
- b. Failure to establish pilot flame.
- c. Failure to establish main flame.
- d. Low-water cutoff.
- e. High temperature cutoff.

#### 2.3.5.1 Low-water Cutoff

Low-water cutoff shall be provided to stop the burner and draft fan when the water level drops below a predetermined point. The cutoff shall consist of a float chamber with float, float switch, and drain valve. The float switch shall be mounted on the float chamber with a packless-type leakproof connection. The float mechanism and drain valve shall be constructed of a corrosion-resistant material. The low-water cutoff shall be UL-06 listed and shall be furnished with approved fittings and installed according to ASME boiler code requirements. The following type of low-water cutoff shall be utilized.

- a. Feedwater Regulator with Low-Water Cutoff: Regulator shall be an approved design sized for the application. A regulator shall be provided for each boiler. The feeder shall be so arranged that water will be fed to the boiler automatically when the water level in the boiler drops below a preset point and will actuate the alarm bell when the water level reaches the low danger point. The boiler feeder shall be arranged so that the burner and forced-draft fan will stop whenever the water level drops below a preset danger point. The boiler feeder shall be constructed so that the feedwater valve and seat are isolated from the float chamber to prevent overheating of the feed water and precipitation of scale on either the valve or seat. Each float mechanism, valve, and seat shall be constructed of an approved, durable, corrosion-resistant steel alloy. Valve seats shall be removable and renewable. The regulator shall be equipped with a large, self-cleaning strainer. The drain valve on the regulator shall be the gate or other straight-through type.

#### 2.3.5.2 Water Flow Interlock

Hot water boiler limit controls shall be provided to include protection for low boiler water flow and high boiler water temperature. The limit controls shall be interlocked with the combustion control system to effect boiler alarm and shutdown. The controls shall not allow boiler startup unless hot water flow is proven.

### 2.4 PUMPS

#### 2.4.1 Hot Water and Boiler Circulating Pumps

Circulating pumps for hot water shall be electrically driven single-stage centrifugal type and have a capacity not less than indicated. Boiler circulating pumps shall be supported on a concrete foundation with a cast iron or structural steel base and shall be flexible-coupled shaft. The boiler circulating pumps shall be horizontal split case type. Hot water

circulating pumps shall be supported on a concrete foundation with a cast iron or structural steel base and shall have a flexible-coupled shaft. The hot water circulating pumps shall be end-suction, centrifugal type with vertically split pump case. The pump shaft shall be constructed of corrosion-resistant alloy steel, sleeve bearings and glands of bronze designed to accommodate a mechanical seal, and the housing of close-grained cast iron. Pump seals shall be capable of withstanding 115 degrees C temperature without external cooling. The motor shall have sufficient power for the service required, shall be of a type approved by the manufacturer of the pump, shall be suitable for the available electric service, and shall conform to the requirements of paragraph ELECTRICAL EQUIPMENT. Each pump suction and discharge connection shall be provided with a pressure gauge as specified. The boiler and hot water circulating pump discharge heater shall be provided with a flow switch. Flow switch unit shall be a self-contained swinging vane type to indicate fluid flow. Switch shall be a SPDT with 120-volt, 15-ampere rating.

## 2.5 HEATING AND VENTILATING UNITS

Heating and ventilating units and associated equipment shall be in accordance with Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

## 2.6 AIR HANDLING UNITS

Air handling units and associated equipment shall be in accordance with Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

## 2.7 FITTINGS AND ACCESSORIES

Boiler fittings and accessories shall be installed with each boiler in accordance with ASME BPV IV, unless otherwise specified.

### 2.7.1 Conventional Breeching and Stacks

#### 2.7.1.1 Breeching

Each boiler shall be connected to the stack or flue by breeching constructed of black steel sheets not less than 1.2 mm thick nor less than thickness of stack, whichever is larger. The clear distance between any portion of the breeching surface and any combustible material shall not be less than that specified in NFPA 211. Joints and seams shall be securely fastened and made airtight. Suitable hinged and gasketed cleanouts shall be provided, which will permit cleaning the entire smoke connection without dismantling. Flexible-type expansion joints shall be provided as required and shall not require packing.

#### 2.7.1.2 Stacks

Prefabricated double wall stacks system shall extend above the roof to the height indicated. The inner stack shall be 304 stainless steel having a thickness of not less than 0.89 mm. The outer stack shall be sheet steel having a thickness of not less than 0.635 mm. A method of maintaining concentricity between the inner and outer stacks shall be incorporated. The joints between the stack sections shall be sealed to prevent flue gas leakage. A 7.92 mm diameter hole shall be provided in the stack not greater than 150 mm from the furnace flue outlet for sampling of the exit gases. A

method shall be provided to seal the hole to prevent exhaust gases from entering the boiler room when samples are not being taken. Each stack shall be provided complete with rain hood.

#### 2.7.2 Expansion Tank

The hot water pressurization system shall include a diaphragm-type expansion tank which will accommodate the expanded water of the system generated within the normal operating temperature range, limiting the pressure increase at all components in the system to the maximum allowable pressure at those components. The only air in the system shall be the permanent sealed-in air cushion contained in the diaphragm-type tank. The sizes shall be as indicated. The expansion tank shall be welded steel, constructed, tested, and stamped in accordance with ASME BPV VIII Div 1 for a working pressure of 861.9 kPa and precharged to the minimum operating pressure of 241.3 kPa. The tank's air chamber shall be fitted with an air charging valve and pressure gauge. The tank shall be supported by steel legs or bases for vertical installation. The tank shall have lifting rings and a drain connection. All components shall be suitable for a maximum operating temperature of 120 degrees C.

#### 2.7.3 Air Separator

External air separation tank shall be steel, constructed, tested and stamped in accordance with ASME BPV VIII Div 1 for a working pressure of 861.9 kPa. The capacity of the air separation tank indicated is minimum.

#### 2.7.4 Filters

Filters shall conform to ASTM F 872.

#### 2.7.5 Foundation (Setting) Materials

##### 2.7.5.1 Firebrick

Firebrick shall be ASTM C 27 class as recommended by boiler manufacturer.

##### 2.7.5.2 Tile

Tile shall be ASTM C 34, Grade LBX.

##### 2.7.5.3 Insulating Brick

Insulating brick shall comply with ASTM C 155.

##### 2.7.5.4 Refractory Mortar

Refractory mortar shall comply with ASTM F 1097.

##### 2.7.5.5 Castable Refractories

Castable refractories shall be ASTM C 401. The minimum modulus of rupture for transverse strength shall be not less than 4136 kPa after being heat soaked for 5 hours or more at a temperature in excess of 1371.1 degrees C.

## 2.7.6 Steel Sheets

### 2.7.6.1 Galvanized Steel

Galvanized steel shall be ASTM A 653.

### 2.7.6.2 Uncoated Steel

Uncoated steel shall be ASTM A 366, composition, condition, and finish best suited to the intended use. Gauge numbers specified refer to manufacturer's standard gauge.

## 2.7.7 Gaskets

Gaskets shall be nonasbestos material in accordance with ASME B16.21, full face or self-centering type. The gaskets shall be of the spiral wound type with graphite filler material.

## 2.7.8 Steel Pipe and Fittings

### 2.7.8.1 Steel Pipe

Steel pipe shall be ASTM A 53, Type E or S, Grade A or B, black steel, standard weight.

### 2.7.8.2 Steel Pipe Fittings

Fittings shall have the manufacturer's trademark affixed in accordance with MSS SP-25 so as to permanently identify the manufacturer.

### 2.7.8.3 Steel Flanges

Flanged fittings including flanges, bolts, nuts, bolt patterns, etc. shall be in accordance with ASME B16.5 class 150 and shall have the manufacturers trademark affixed in accordance with MSS SP-25. Flange material shall conform to ASTM A 105. Flanges for high temperature water systems shall be serrated or raised-face type. Blind flange material shall conform to ASTM A 516 cold service and ASTM A 515 for hot service. Bolts shall be high strength or intermediate strength with material conforming to ASTM A 193.

### 2.7.8.4 Welded Fittings

Welded fittings shall conform to ASTM A 234 with WPA marking. Buttwelded fittings shall conform to ASME B16.9, and socket-welded fittings shall conform to ASME B16.11.

### 2.7.8.5 Cast-Iron Fittings

Fittings shall be ASME B16.4, Class 125, type required to match connecting piping.

### 2.7.8.6 Malleable-Iron Fittings

Fittings shall be ASME B16.3, type as required to match connecting piping.



#### 2.7.8.7 Unions

Unions shall be ASME B16.39, Class 150.

#### 2.7.8.8 Threads

Pipe threads shall conform to ASME B1.20.1.

#### 2.7.8.9 Grooved Mechanical fittings

Joints and fittings shall be designed for not less than 862 kPa service and shall be the product of the same manufacturer. Fitting and coupling houses shall be malleable iron conforming to ASTM A 47, Grade 32510; ductile iron conforming to ASTM A 536, Grade 65-45-12; or steel conforming to ASTM A 106, Grade B or ASTM A 53. Gaskets shall be molded synthetic rubber with central cavity, pressure responsive configuration and shall conform to ASTM D 2000, Grade No. 2CA615A15B44F17Z for circulating medium up to 110 degrees C or Grade N0. M3BA610A15B44Z for circulating medium up to 93 degrees C. Grooved joints shall conform to AWWA C606. Coupling nuts and bolts shall be steel and shall conform to ASTM A 183.

#### 2.7.9 Copper Tubing and Fittings

##### 2.7.9.1 Copper Tubing

Tubing shall be ASTM B 88, Type K or L. Adapters for copper tubing shall be brass or bronze for brazed fittings.

##### 2.7.9.2 Solder-Joint Pressure Fittings

Wrought copper and bronze solder-joint pressure fittings shall conform to ASME B16.22 and ASTM B 75. Cast copper alloy solder-joint pressure fittings shall conform to ASME B16.18 and ASTM B 828.

##### 2.7.9.3 Flared Fittings

Cast copper alloy fittings for flared copper tube shall conform to ASME B16.26 and ASTM B 62.

##### 2.7.9.4 Adapters

Adapters may be used for connecting tubing to flanges and to threaded ends of valves and equipment. Extracted brazed tee joints produced with an acceptable tool and installed as recommended by the manufacturer may be used.

##### 2.7.9.5 Threaded Fittings

Cast bronze threaded fittings shall conform to ASME B16.15.

##### 2.7.9.6 Brazing Material

Brazing material shall conform to AWS A5.8.

#### 2.7.9.7 Brazing Flux

Flux shall be in paste or liquid form appropriate for use with brazing material. Flux shall be as follows: lead-free; have a 100 percent flushable residue; contain slightly acidic reagents; contain potassium borides, and contain fluorides. Silver brazing materials shall be in accordance with AWS A5.8.

#### 2.7.9.8 Solder Material

Solder metal shall conform to ASTM B 32 95-5 tin-antimony.

#### 2.7.9.9 Solder Flux

Flux shall be liquid form, non-corrosive, and conform to ASTM B 813, Standard Test 1.

#### 2.7.10 Dielectric Unions

Dielectric unions shall have metal connections on both ends. The ends shall be threaded, flanged, or brazed to match adjacent piping. Metal parts of the union shall be separated so that the electrical current is below 1 percent of the galvanic current which would exist upon metal-to-metal contact.

#### 2.7.11 Flexible Pipe Connectors

Flexible pipe connectors shall be designed for 861.8 kPa or 1034.2 kPa service. Connectors shall be installed where indicated. The flexible section shall be constructed of rubber, tetrafluoroethylene resin, or corrosion-resisting steel, bronze, monel, or galvanized steel. Materials used and the configuration shall be suitable for the pressure, vacuum, and temperature medium. The flexible section shall be suitable for service intended and may have threaded, welded, soldered, flanged, or socket ends. Flanged assemblies shall be equipped with limit bolts to restrict maximum travel to the manufacturer's standard limits. Unless otherwise indicated, the length of the flexible connectors shall be as recommended by the manufacturer for the service intended. Internal sleeves or liners, compatible with circulating medium, shall be provided when recommended by the manufacturer. Covers to protect the bellows shall be provided where indicated.

#### 2.7.12 Pipe Supports

Pipe supports shall conform to MSS SP-58 and MSS SP-69.

#### 2.7.13 Pipe Expansion

##### 2.7.13.1 Expansion Loops

Expansion loops and offsets shall provide adequate expansion of the main straight runs of the system within the stress limits specified in ASME B31.1. The loops and offsets shall be cold-sprung and installed where indicated. Pipe guides and anchors shall be provided as indicated.

#### 2.7.14 Valves

Valves shall be Class 125 and shall be suitable for the application. Grooved ends per AWWA C606 may be used for water service only. Valves in non-boiler external piping shall meet the material, fabrication and operating requirements of ASME B31.1. The connection type of all valves shall match the same type of connection required for the piping on which installed.

##### 2.7.14.1 Gate Valves

Gate valves 65 mm and smaller shall conform to MSS SP-80 bronze rising stem, threaded, solder, or flanged ends. Gate valves 80 mm and larger shall conform to MSS SP-70 cast iron bronze trim, outside screw and yoke, flanged, or threaded ends.

##### 2.7.14.2 Globe Valves

Globe valves 65 mm and smaller shall conform to MSS SP-80, bronze, threaded, soldered, or flanged ends. Globe valves 80 mm and larger shall conform to MSS SP-85, cast iron, bronze trim, flanged, or threaded ends.

##### 2.7.14.3 Check Valves

Check valves 65 mm and smaller shall conform to MSS SP-80, bronze, threaded, soldered, or flanged ends. Check valves 80 mm and larger shall conform to MSS SP-71, cast iron, bronze trim, flanged, or threaded ends.

##### 2.7.14.4 Angle Valves

Angle valves 65 mm and smaller shall conform to MSS SP-80 bronze, threaded, soldered, or flanged ends. Angle valves 80 mm and larger shall conform to MSS SP-85, cast iron, bronze trim, flanged, or threaded ends.

##### 2.7.14.5 Ball Valves

Ball valves 15 mm and larger shall conform to MSS SP-72 or MSS SP-110, ductile iron or bronze, threaded, soldered, or flanged ends.

##### 2.7.14.6 Plug Valves

Plug valves 51 mm and larger shall conform to MSS SP-78. Plug valves smaller than 51 mm shall conform to ASME B16.34.

##### 2.7.14.7 Grooved End Valves

Valves with grooved ends per AWWA C606 may be used if the valve manufacturer certifies that their performance meets the requirements of the standards indicated for each type of valve.

##### 2.7.14.8 Balancing Valves

Balancing valves shall have meter connections with positive shutoff valves. An integral pointer shall register the degree of valve opening. Valves shall be calibrated so that flow rate can be determined when valve opening in degrees and pressure differential across valve is known. Each balancing valve shall be constructed with internal seals to prevent leakage and shall be supplied with preformed insulation. Valves shall be suitable for 120

degrees C temperature and working pressure of the pipe in which installed. Valve bodies shall be provided with tapped openings and pipe extensions with shutoff valves outside of pipe insulation. The pipe extensions shall be provided with quick connecting hose fittings for a portable meter to measure the pressure differential. One portable differential meter shall be furnished. The meter suitable for the operating pressure specified shall be complete with hoses, vent, and shutoff valves, and carrying case.

#### 2.7.14.9 Butterfly Valves

Butterfly valves shall be 2-flange type or lug wafer type, and shall be bubbletight at 1135 kPa. Valve bodies shall be cast iron, malleable iron, or steel. ASTM A 167, Type 404 or Type 316, corrosion resisting steel stems, bronze, or corrosion resisting steel discs, and synthetic rubber seats shall be provided. Valves smaller than 200 mm shall have throttling handles with a minimum of seven locking positions. Valves 200 mm and larger shall have totally enclosed manual gear operators with adjustable balance return stops and position indicators. Valves in insulated lines shall have extended neck to accommodate insulation thickness.

#### 2.7.14.10 Drain valves

Drain valves shall be provided at each drain point of blowdown as recommended by the boiler manufacturer. Piping shall conform to ASME BPV IV and ASTM A 53.

#### 2.7.14.11 Safety Valves

Safety valves shall have steel bodies and shall be equipped with corrosion-resistant trim and valve seats. The valves shall be properly guided and shall be positive closing so that no leakage can occur. Adjustment of the desired back-pressure shall cover the range between 15 and 70 kPa. The adjustment shall be made externally, and any shafts extending through the valve body shall be provided with adjustable stuffing boxes having renewable packing. Boiler safety valves of proper size and of the required number, in accordance with ASME BPV IV, shall be installed so that the discharge will be through piping extended to building exterior. Each discharge pipe for hot water service shall be pitched away from the valve seat.

#### 2.7.15 Strainers

Basket and "Y" type strainers shall be the same size as the pipelines in which they are installed. The strainer bodies shall be heavy and durable, fabricated of cast iron, and shall have bottoms drilled and tapped with a gate valve attached for blowdown purposes. Strainers shall be designed for 861.9 kPa service. The bodies shall have arrows clearly cast on the sides indicating the direction of flow. Each strainer shall be equipped with an easily removable cover and sediment screen. The screen shall be made of 0.795 mm thick brass sheet with small perforations numbering not less than 620,000 per square m to provide a net free area through the basket of at least 3.30 times that of the entering pipe. The flow shall be into the screen and out through the perforations.

#### 2.7.16 Pressure Gauges

Gauges shall conform to ASME B40.1 and shall be provided with throttling type needle valve or a pulsation damper and shutoff valve. Minimum dial

size shall be 90 mm. A pressure gauge shall be provided for each boiler in a visible location on the boiler.

#### 2.7.17 Thermometers

Thermometers shall be provided with wells and separable corrosion-resistant steel sockets. Thermometers for inlet water and outlet water for each hot water boiler shall be provided in a visible location on the boiler. Thermometers shall have brass, malleable iron, or aluminum alloy case and frame, clear protective face, permanently stabilized glass tube with indicating-fluid column, white face, black numbers, and a minimum 225 mm scale.

#### 2.7.18 Air Vents

##### 2.7.18.1 Manual Air Vents

Manual air vents shall be brass or bronze valves or cocks suitable for the pressure rating of the piping system and furnished with threaded plugs or caps.

##### 2.7.18.2 Automatic Air Vents

Automatic air vents shall be 20 mm quick-venting float and vacuum air valves. Each air vent valve shall have a large port permitting the expulsion of the air without developing excessive back pressure, a noncollapsible metal float which will close the valve and prevent the loss of water from the system, an air seal that will effectively close and prevent the re-entry of air into the system when subatmospheric pressures prevail therein, and a thermostatic member that will close the port against the passage of steam from the system. The name of the manufacturer shall be clearly stamped on the outside of each valve. The air vent valve shall be suitable for the pressure rating of the piping system.

### 2.8 ELECTRICAL EQUIPMENT

Electric motor-driven equipment shall be provided complete with motors, motor starters, and necessary control devices. Electrical equipment, motor control devices, motor efficiencies and wiring shall be as specified in Section 16415 ELECTRICAL WORK, INTERIOR. Motors which are not an integral part of a packaged boiler shall be rated for high efficiency service. Motors which are an integral part of the packaged boiler shall be the highest efficiency available by the manufacturer of the packaged boiler. Motor starters shall be provided complete with properly sized thermal overload protections and other appurtenances necessary for the motor control specified. Starters shall be furnished in general purpose enclosures. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices but not shown shall be provided.

#### 2.8.1 Motor Ratings

Motors shall be suitable for the voltage and frequency provided. Motors shall be of sufficient capacity to drive the equipment at the specified capacity without exceeding the nameplate rating on the motor.

### 2.8.2 Motor Controls

Motor controllers shall be provided complete with properly sized thermal overload protection. Manual or automatic control and protective or signal devices required for the operation specified and any wiring required to such devices shall be provided.

## 2.9 INSULATION

Shop and field-applied insulation shall be as specified in Section 15250 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

## 2.10 TOOLS

Special tools shall be furnished. Special tools shall include uncommon tools necessary for the operation and maintenance of boilers, burners, pumps, fans, controls, meters, special piping systems, and other equipment. Small hand tools shall be furnished within a suitable cabinet, mounted where directed.

### 2.10.1 Breeching Cleaner

A cleaner shall be provided to clean the breeching. The cleaner shall have a jointed handle of sufficient length to clean the breeching without dismantling.

### 2.10.2 Tube Cleaner

If a watertube boiler is being furnished, a water-driven tube cleaner with three rotary cutters and rotary wire brush complete with the necessary length of armored water hose, valves, and other appurtenances necessary for operation shall be provided. Tube cleaner and rotary brush shall be provided for each size of water tube in the boiler, with one extra set of cutters for each size cleaner. Necessary valves and fittings shall be provided to permit ready connection of the cleaner hose to a high-pressure pump for cold water supply to operate the cleaner.

### 2.10.3 Wrenches

Wrenches shall be provided as required for specialty fittings such as manholes, handholes, and cleanouts. One set of extra gaskets shall be provided for all manholes and handholes, for pump barrels, and other similar items of equipment. Gaskets shall be packaged and properly identified.

## 2.11 BOILER WATER TREATMENT

The water treatment system shall be capable of feeding chemicals and bleeding the system to prevent corrosion and scale within the boiler and piping distribution system. The water shall be treated to maintain the conditions recommended by the boiler manufacturer. Chemicals shall meet required federal, state, and local environmental regulations for the treatment of boilers and discharge to the sanitary sewer. The services of a company regularly engaged in the treatment of boilers shall be used to determine the correct chemicals and concentrations required for water treatment. The company shall maintain the chemical treatment and provide all chemicals required for a period of 1 year from the date of occupancy. Filming amines and proprietary chemicals shall not be used. The water

treatment chemicals shall remain stable throughout the operating temperature range of the system and shall be compatible with pump seals and other elements of the system.

#### 2.11.1 Chemical Shot Feeder

A shot feeder shall be provided as indicated. Size and capacity of feeder shall be based upon local requirements and water analysis. The feeder shall be furnished with an air vent, gauge glass, funnel, valves, fittings, and piping.

#### 2.11.2 Chemical Piping

The piping and fittings shall be constructed of stainless steel.

#### 2.11.3 Test Kits

One test kit of each type required to determine the water quality as outlined within the operation and maintenance manuals shall be provided.

### 3 EXECUTION

#### 3.1 ERECTION OF BOILER AND AUXILIARY EQUIPMENT

Boiler and auxiliary equipment shall be installed in accordance with manufacturer's written instructions. Proper provision shall be made for expansion and contraction between boiler foundation and floor. This joint shall be packed with suitable nonasbestos rope and filled with suitable compound that will not become soft at a temperature of 40 degrees C. Boilers and firing equipment shall be supported from the foundations by structural steel completely independent of all brickwork. Boiler supports shall permit free expansion and contraction of each portion of the boiler without placing undue stress on any part of the boiler or setting. Boiler breeching shall be as indicated with full provision for expansion and contraction between all interconnected components.

#### 3.2 PIPING INSTALLATION

Unless otherwise specified, nonboiler external pipe and fittings shall conform to the requirements of ASME B31.1. Pipe installed shall be cut accurately to suit field conditions, shall be installed without springing or forcing, and shall properly clear windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted. Pipes shall be free of burrs, oil, grease and other foreign material and shall be installed to permit free expansion and contraction without damaging the building structure, pipe, pipe joints, or pipe supports. Changes in direction shall be made with fittings, except that bending of pipe 100 mm and smaller will be permitted provided a pipe bender is used and wide sweep bends are formed. The centerline radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted. Vent pipes shall be carried through the roof as directed and shall be properly flashed. Unless otherwise indicated, horizontal supply mains shall pitch down in the direction of flow with a grade of not less than 0.2 percent. Open ends of pipelines and equipment shall be properly capped or plugged during installation to keep dirt or other foreign materials out of the systems. Pipe not otherwise specified shall be

uncoated. Unless otherwise specified or shown, final connections to equipment shall be made with malleable-iron unions for steel pipe 65 mm or less in diameter and with flanges for pipe 80 mm or more in diameter. Unions for copper pipe or tubing shall be brass or bronze. Reducing fittings shall be used for changes in pipe sizes. In horizontal hot water lines, reducing fittings shall be eccentric type to maintain the top of the lines at the same level to prevent air binding.

#### 3.2.1 Cold Water Connections

Cold water fill connections shall be made to the water supply system as indicated. Necessary pipe, fittings, and valves required for water connections between the boiler and cold water main shall be provided as shown. The pressure regulating valve shall be of a type that will not stick or allow pressure to build up on the low side. The valve shall be set to maintain a terminal pressure of approximately 35 kPa in excess of the static head on the system and shall operate within a 15 kPa tolerance regardless of cold water supply piping pressure and without objectionable noise under any condition of operation.

#### 3.2.2 Hot Water Piping and Fittings

Pipe shall be black steel or copper tubing. Fittings for steel piping shall be black malleable iron or cast iron to suit piping. Fittings adjacent to valves shall suit valve material. Grooved mechanical fittings will not be allowed for water temperatures above 110 degrees C.

#### 3.2.3 Vent Piping and Fittings

Vent piping shall be black steel. Fittings shall be black malleable iron or cast iron to suit piping.

#### 3.2.4 Gauge Piping

Piping shall be copper tubing.

#### 3.2.5 Joints

Joints between sections of steel pipe and between steel pipe and fittings shall be threaded, grooved, flanged or welded as indicated or specified. Except as otherwise specified, fittings 25 mm and smaller shall be threaded; fittings 32 mm and up to but not including 80 mm shall be either threaded, grooved, or welded; and fittings 80 mm and larger shall be either flanged, grooved, or welded. Pipe and fittings 32 mm and larger installed in inaccessible conduit or trenches beneath concrete floor slabs shall be welded. Connections to equipment shall be made with black malleable-iron unions for pipe 65 mm or smaller in diameter and with flanges for pipe 80 mm or larger in diameter. Joints between sections of copper tubing or pipe shall be flared, soldered, or brazed.

##### 3.2.5.1 Threaded Joints

Threaded joints shall be made with tapered threads properly cut and shall be made perfectly tight with a stiff mixture of graphite and oil or with polytetrafluoroethylene tape applied to the male threads only and in no case to the fittings.



#### 3.2.5.2 Welded Joints

Welded joints shall be in accordance with paragraph GENERAL REQUIREMENTS unless otherwise specified. Changes in direction of piping shall be made with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be permitted. Branch connections may be made with either welding tees or forged branch outlet fittings, either being acceptable without size limitation. Branch outlet fittings, where used, shall be forged, flared for improved flow characteristics where attached to the run, reinforced against external strains, and designed to withstand full pipe bursting strength. Socket weld joints shall be assembled so that the space between the end of the pipe and the bottom of the socket is no less than 1.5 mm and no more than 3 mm.

#### 3.2.5.3 Grooved Mechanical Joints

Grooved mechanical joints may be provided for hot water systems in lieu of unions, welded, flanged, or screwed piping connections in low temperature hot water systems where the temperature of the circulating medium does not exceed 110 degrees C. Grooves shall be prepared according to the coupling manufacturer's instructions. Pipe and groove dimensions shall comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field shall be measured using a "go/no-go" gauge, vernier or dial caliper, or narrow-land micrometer. Groove width and dimension of groove from end of pipe shall be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints shall not be used in concealed locations. Mechanical joints shall use rigid mechanical pipe couplings, except at equipment connections. At equipment connections, flexible couplings may be used. Coupling shall be of the bolted type for use with grooved end pipes, fittings, valves, and strainers. Couplings shall be self-centering and shall engage in a watertight couple.

#### 3.2.5.4 Flared and Brazed Copper Pipe and Tubing

Tubing shall be cut square, and burrs shall be removed. Both inside of fittings and outside of tubing shall be cleaned thoroughly with sand cloth or steel wire brush before brazing. Annealing of fittings and hard-drawn tubing shall not occur when making connections. Installation shall be made in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Brazed joints shall be made in conformance with AWS B2.2, MSS SP-73, and CDA 404/0 RR with flux. Copper-to-copper joints shall include the use of copper-phosphorous or copper-phosphorous-silver brazing metal without flux. Brazing of dissimilar metals (copper to bronze or brass) shall include the use of flux with either a copper-phosphorous, copper-phosphorous-silver or a silver brazing filler metal. Joints for flared fittings shall be of the compression pattern. Swing joints or offsets shall be provided in all branch connections, mains, and risers to provide for expansion and contraction forces without undue stress to the fittings or to short lengths of pipe or tubing. Flared or brazed copper tubing to pipe adapters shall be provided where necessary for joining threaded pipe to copper tubing.

### 3.2.5.5 Soldered Joints

Soldered joints shall be made with flux and are only acceptable for lines 50 mm and smaller. Soldered joints shall conform to ASME B31.5 and CDA 404/0 RR.

### 3.2.5.6 Copper Tube Extracted Joint

An extruded mechanical tee joint may be made in copper tube. Joint shall be produced with an appropriate tool by drilling a pilot hole and drawing out the tube surface to form a collar having a minimum height of three times the thickness of the tube wall. To prevent the branch tube from being inserted beyond the depth of the extracted joint, dimpled depth stops shall be provided. The branch tube shall be notched for proper penetration into fitting to assure a free flow joint. Extracted joints shall be brazed using a copper phosphorous classification brazing filler metal. Soldered joints will not be permitted.

### 3.2.6 Flanges and Unions

Flanges shall be faced true, provided with 1.6 mm thick gaskets, and made square and tight. Where steel flanges mate with cast-iron flanged fittings, valves, or equipment, they shall be provided with flat faces and full face gaskets. Union or flange joints shall be provided in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control valves, and other similar items. Dielectric pipe unions shall be provided between ferrous and nonferrous piping to prevent galvanic corrosion. The dielectric unions shall have metal connections on both ends. The ends shall be threaded, flanged, or brazed to match adjacent piping. The metal parts of the union shall be separated so that the electrical current is below 1 percent of the galvanic current which would exist upon metal-to-metal contact. Gaskets, flanges, and unions shall be installed in accordance with manufacturer's recommendations.

### 3.2.7 Branch Connections

#### 3.2.7.1 Branch Connections for Hot Water Systems

Branches from the main shall pitch up or down as shown to prevent air entrapment. Connections shall ensure unrestricted circulation, eliminate air pockets, and permit complete drainage of the system. Branches shall pitch with a grade of not less than 8 mm in 1 m. Special flow fittings shall be standard catalog products and shall be installed as recommended by the manufacturer.

### 3.2.8 Flared, Brazed, and Soldered Copper Pipe and Tubing

Copper tubing shall be flared, brazed, or soldered. Tubing shall be cut square, and burrs shall be removed. Both inside of fittings and outside of tubing shall be cleaned thoroughly with sand cloth or steel wire brush before brazing. Annealing of fittings and hard-drawn tubing shall not occur when making connections. Installation shall be made in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Joints for flared fittings shall be of the compression pattern. Swing joints or offsets shall be provided on branch connections, mains, and risers to provide for

expansion and contraction forces without undue stress to the fittings or to short lengths of pipe or tubing. Pipe adapters shall be provided where necessary for joining threaded pipe to copper tubing. Braze joints shall be made in conformance with MSS SP-73, and CDA 404/0 RR. Copper-to-copper joints shall include the use of copper-phosphorous or copper-phosphorous-silver brazing metal without flux. Brazing of dissimilar metals (copper to bronze or brass) shall include the use of flux with either a copper-phosphorous, copper-phosphorous-silver, or a silver brazing filler metal. Soldered joints shall be made with flux and are only acceptable for lines 50 mm or smaller. Soldered joints shall conform to ASME B31.5 and shall be in accordance with CDA 404/0 RR.

### 3.2.9 Copper Tube Extracted Joint

An extracted mechanical tee joint may be made in copper tube. Joint shall be produced with an appropriate tool by drilling a pilot hole and drawing out the tube surface to form a collar having a minimum height of three times the thickness of the tube wall. To prevent the branch tube from being inserted beyond the depth of the extracted joint, dimpled depth stops shall be provided. The branch tube shall be notched for proper penetration into fitting to assure a free flow joint. Extracted joints shall be brazed using a copper phosphorous classification brazing filler metal. Soldered joints will not be permitted.

### 3.2.10 Supports

#### 3.2.10.1 General

Hangers used to support piping 50 mm and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Pipe guides and anchors shall be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Piping subjected to vertical movement when operating temperatures exceed ambient temperatures shall be supported by variable spring hangers and supports or by constant support hangers.

#### 3.2.10.2 Seismic Requirements for Supports and Structural Bracing

Piping and attached valves shall be supported and braced to resist seismic loads as specified in Section 13080 SEISMIC PROTECTION FOR MECHANICAL, ELECTRICAL EQUIPMENT and as shown. Structural steel required for reinforcement to properly support piping, headers, and equipment, but not shown, shall be provided in this section. Material used for supports shall be as specified in Section 05120 STRUCTURAL STEEL.

#### 3.2.10.3 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69, except as modified herein.

- a. Types 5, 12, and 26 shall not be used.
- b. Type 3 shall not be used on insulated pipe which has a vapor barrier. Type 3 may be used on insulated pipe that does not have a vapor barrier if clamped directly to the pipe, if the clamp bottom does not extend through the insulation, and if the top clamp attachment does not contact the insulation during pipe movement.

- c. Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for Type 18 inserts.
- d. Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and have both locknuts and retaining devices furnished by the manufacturer. Field fabricated C-clamp bodies or retaining devices are not acceptable.
- e. Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.
- f. Type 24 may be used only on trapeze hanger systems or on fabricated frames.
- g. Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 300 mm from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 1500 mm apart at valves.
- h. Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 4500 mm, not more than 2400 mm from end of risers, and at vent terminations.
- i. Type 35 guides using steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.
  - (1) Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 100 mm and larger, a Type 39 saddle may be welded to the pipe and freely rested on a steel plate. On piping under 100 mm, a Type 40 protection shield may be attached to the pipe or insulation and freely rested on a steel slide plate.
  - (2) Where there are high system temperatures and welding to piping is not desirable, the Type 35 guide shall include a pipe cradle welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 100 mm or by an amount adequate for the insulation, whichever is greater.
- j. Except for Type 3, pipe hangers on horizontal insulated pipe shall be the size of the outside diameter of the insulation.
- k. Piping in trenches shall be supported as indicated.
- l. Structural steel attachments and brackets required to support piping, headers, and equipment, but not shown, shall be provided under this section. Material and installation shall be as specified under Section 05120 STRUCTURAL STEEL. Pipe hanger loads suspended from steel joist between panel points shall not exceed 22 kg. Loads exceeding 22 kg shall be suspended from panel points.

#### 3.2.10.4 Multiple Pipe Runs

In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support member shall not exceed the hanger and support spacing required for any individual pipe in the multiple pipe run. The clips or clamps shall be rigidly attached to the common base member. A clearance of 3 mm shall be provided between the pipe insulation and the clip or clamp for piping which may be subjected to thermal expansion.

#### 3.2.11 Anchors

Anchors shall be provided where necessary to localize expansion or to prevent undue strain on piping. Anchors shall consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Anchor braces shall be installed in the most effective manner to secure the desired results, using turnbuckles where required. Supports, anchors, or stays shall not be attached where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline.

#### 3.2.12 Valves

Valves shall be installed where indicated, specified, and required for functioning and servicing of the systems. Valves shall be safely accessible. Swing check valves shall be installed upright in horizontal lines and in vertical lines only when flow is in the upward direction. Gate and globe valves shall be installed with stems horizontal or above. Valves to be brazed shall be disassembled prior to brazing and all packing removed. After brazing, the valves shall be allowed to cool before reassembling.

#### 3.2.13 Pipe Sleeves

Pipe passing through concrete or masonry walls or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. A waterproofing clamping flange shall be installed as indicated where membranes are involved. Sleeves shall not be installed in structural members except where indicated or approved. Rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective wall, floor, or roof. Sleeves through walls shall be cut flush with wall surface. Sleeves through floors shall extend above top surface of floor a sufficient distance to allow proper flashing or finishing. Sleeves through roofs shall extend above the top surface of roof at least 150 mm for proper flashing or finishing. Unless otherwise indicated, sleeves shall be sized to provide a minimum clearance of 6 mm between bare pipe and sleeves or between jacket over insulation and sleeves. Sleeves in waterproofing membrane floors, bearing walls, and wet areas shall be galvanized steel pipe or cast-iron pipe. Sleeves in nonbearing walls, floors, or ceilings may be galvanized steel pipe, cast-iron pipe, or galvanized sheet metal with lock-type longitudinal seam. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over insulation and sleeve in nonfire rated walls shall be sealed as indicated and specified in Section 07920 JOINT SEALING. Metal jackets shall be provided over insulation passing through exterior walls, firewalls, fire partitions, floors, or roofs.

Metal jackets shall not be thinner than 0.1524 mm thick aluminum, if corrugated, and 0.4 mm thick aluminum, if smooth.

Metal jackets shall be secured with aluminum or stainless steel bands not less than 9 mm wide and not more than 200 mm apart. When penetrating roofs and before fitting the metal jacket into place, a 15 mm wide strip of sealant shall be run vertically along the inside of the longitudinal joint of the metal jacket from a point below the backup material to a minimum height of 1000 mm above the roof. If the pipe turns from vertical to horizontal, the sealant strip shall be run to a point just beyond the first elbow. When penetrating waterproofing membrane for floors, the metal jacket shall extend from a point below the back-up material to a minimum distance of 50 mm above the flashing. For other areas, the metal jacket shall extend from a point below the backup material to a point 300 mm above material to a minimum distance of 50 mm above the flashing. For other areas, the metal jacket shall extend from a point below the backup material to a point 300 mm above the floor; when passing through walls above grade, the jacket shall extend at least 100 mm beyond each side of the wall.

#### 3.2.13.1 Pipes Passing Through Waterproofing Membranes

In addition to the pipe sleeves referred to above, pipes passing through waterproofing membranes shall be provided with a 1.6 mm lead flashing or a 0.55 mm copper flashing, each within an integral skirt or flange. Flashing shall be suitably formed, and the skirt or flange shall extend not less than 200 mm from the pipe and shall set over the membrane in a troweled coating of bituminous cement. The flashing shall extend above the roof or floor a minimum of 250 mm. The annular space between the flashing and the bare pipe or between the flashing and the metal-jacket-covered insulation shall be sealed as indicated. Pipes up to and including 250 mm in diameter which pass through waterproofing membrane may be installed through a cast-iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Waterproofing membrane shall be clamped into place and sealant shall be placed in the caulking recess.

#### 3.2.13.2 Optional Modular Mechanical Sealing Assembly

At the option of the Contractor, a modular mechanical type sealing assembly may be installed in the annular space between the sleeve and conduit or pipe in lieu of a waterproofing clamping flange and caulking and sealing specified above. The seals shall include interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion-protected carbon steel bolts, nuts, and pressure plates. The links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal between the pipe/conduit and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe/conduit and sleeve involved.

#### 3.2.13.3 Optional Counterflashing

As alternates to caulking and sealing the annular space between the pipe and flashing or metal-jacket-covered insulation and flashing, counterflashing may consist of standard roof coupling for threaded pipe up to 150 mm in diameter, lead flashing sleeve for dry vents with the sleeve turned down

into the pipe to form a waterproof joint, or a tack-welded or banded-metal rain shield around the pipe, sealed as indicated.

#### 3.2.13.4 Fire Seal

Where pipes pass through firewalls, fire partitions, or floors, a fire seal shall be provided as specified in Section 07270 FIRESTOPPING.

#### 3.2.14 Balancing Valves

Balancing valves shall be installed as indicated.

#### 3.2.15 Thermometer Wells

A thermometer well shall be provided in each return line for each circuit in multicircuit systems.

#### 3.2.16 Air Vents

Air vents shall be installed where shown or directed. Air vents shall be installed in piping at all system high points. The vent shall remain open until water rises in the tank or pipe to a predetermined level at which time it shall close tight. An overflow pipe from the vent shall be run to a point designated by the Contracting Officer's representative. The inlet to the air vent shall have a gate valve or ball valve.

#### 3.2.17 Escutcheons

Escutcheons shall be provided at all finished surfaces where exposed piping, bare or insulated, passes through floors, walls, or ceilings except in boiler, utility, or equipment rooms. Escutcheons shall be fastened securely to pipe or pipe covering and shall be chromium-plated iron or chromium-plated brass, either one-piece or split pattern, held in place by internal spring tension or setscrews.

#### 3.2.18 Drains

A drain connection with a 25 mm gate valve or 20 mm hose bib shall be installed at the lowest point in the return main near the boiler. In addition, threaded drain connections with threaded cap or plug shall be installed on the heat exchanger coil on each unit heater or unit ventilator and wherever required for thorough draining of the system.

#### 3.2.19 Strainer Blow-Down Piping

Strainer blow-down connections shall be fitted with a black steel blow-down pipeline routed to a floor drain and provided with a blow-down valve.

### 3.3 GAS FUEL SYSTEM

Gas piping, fittings, valves, regulators, tests, cleaning, and adjustments shall be in accordance with the Section 15488 GAS PIPING SYSTEMS. NFPA 54 shall be complied with unless otherwise specified. Burners, pilots, and all accessories shall be listed in UL-06. The fuel system shall be provided with a gas tight, manually operated, UL listed stop valve at the gas-supply connections, a gas strainer, a pressure regulator, pressure gauges, a burner-control valve, a safety shutoff valve suitable for size of burner and

sequence of operation, and other components required for safe, efficient, and reliable operation as specified. Approved permanent and ready facilities to permit periodic valve leakage tests on the safety shutoff valve or valves shall be provided.

#### 3.4 FIELD PAINTING

Ferrous metal not specified to be coated at the factory shall be cleaned, prepared, and painted as specified in Section 09900 PAINTING, GENERAL. Exposed pipe covering shall be painted as specified in Section 09900 PAINTING, GENERAL. Aluminum sheath over insulation shall not be painted.

#### 3.5 HEATING SYSTEM TESTS

Before any covering is installed on pipe or heating equipment, the entire heating system's piping, fittings, and terminal heating units shall be hydrostatically tested and proved tight at a pressure of 1-1/2 times the design working pressure. Before pressurizing system for test, items or equipment (e.g., vessels, pumps, instruments, controls, relief valves) rated for pressures below the test pressure shall be blanked off or replaced with spool pieces. Before balancing and final operating test, test blanks and spool pieces shall be removed; and protected instruments and equipment shall be reconnected. With equipment items protected, the system shall be pressurized to test pressure. Pressure shall be held for a period of time sufficient to inspect all welds, joints, and connections for leaks, but not less than 2 hours. No loss of pressure will be allowed. Leaks shall be repaired and repaired joints shall be retested. Caulking of joints shall not be permitted. System shall be drained and after instruments and equipment are reconnected, the system shall be refilled with service medium and maximum operating pressure applied. The pressure shall be held while inspecting these joints and connections for leaks. The leaks shall be repaired and the repaired joints retested. Upon completion of hydrostatic tests and before acceptance of the installation, the Contractor shall balance the heating system in accordance with Section 15990 TESTING, ADJUSTING AND BALANCING OF HVAC SYSTEMS; and operating tests required to demonstrate satisfactory functional and operational efficiency shall be performed. The operating test shall cover a period of at least 24 hours for each system, and shall include, as a minimum, the following specific information in a report, together with conclusions as to the adequacy of the system:

- a. Certification of balancing.
- b. Time, date, and duration of test.
- c. Outside and inside dry bulb temperatures.
- d. Temperature of hot water supply leaving boiler.
- e. Temperature of heating return water from system at boiler inlet.
- f. Quantity of water feed to boiler.
- g. Boiler make, type, serial number, design pressure, and rated capacity.



- h. Fuel burner make, model, and rated capacity; ammeter and voltmeter readings for burner motor.
- i. Circulating pumps make, model, and rated capacity, and ammeter and voltmeter readings for pump motor during operation.
- j. Flue-gas temperature at boiler outlet.
- k. Percent carbon dioxide in flue-gas.
- l. Grade or type and calorific value of fuel.
- m. Draft at boiler flue-gas exit.
- n. Draft or pressure in furnace.
- o. Quantity of water circulated.
- p. Quantity of fuel consumed.

Indicating instruments shall be read at half-hour intervals unless otherwise directed. The Contractor shall furnish all instruments, equipment, and personnel required for the tests and balancing. Fuels, water, and electricity shall be obtained as specified in the SPECIAL CONTRACT REQUIREMENTS. Operating tests shall demonstrate that fuel burners and combustion and safety controls meet the applicable requirements of ASME CSD-1, ANSI Z21.13 , NFPA 8501 , NFPA 85C.

### 3.5.1 Water Treatment Testing

#### 3.5.1.1 Water Quality Test

The boiler water shall be analyzed prior to the acceptance of the facility and a minimum of once a month for a period of 1 year by the water treatment company. The analysis shall include the following information recorded in accordance with ASTM D 596.

Date of Sample	[_____]
Temperature	[_____] degrees C
Silica (SiO <sub>2</sub> )	[_____] ppm (mg/l)
Insoluble	[_____] ppm (mg/l)
Iron and Aluminum Oxides	[_____] ppm (mg/l)
Calcium (Ca)	[_____] ppm (mg/l)
Magnesium (Mg)	[_____] ppm (mg/l)
Sodium and Potassium (Na and K)	[_____] ppm (mg/l)
Carbonate (HCO <sub>3</sub> )	[_____] ppm (mg/l)
Sulfate (SO <sub>4</sub> )	[_____] ppm (mg/l)
Chloride (Cl)	[_____] ppm (mg/l)
Nitrate (NO <sub>3</sub> )	[_____] ppm (mg/l)
Turbidity	[_____] unit
pH	[_____]
Residual Chlorine	[_____] ppm (mg/l)
Total Alkalinity	[_____] epm (meq/l)
Noncarbonate Hardness	[_____] epm (meq/l)
Total Hardness	[_____] epm (meq/l)
Dissolved Solids	[_____] ppm (mg/l)

Fluorine [\_\_\_\_\_] ppm (mg/l)  
Conductivity [\_\_\_\_\_] microhm/cm

If the boiler water is not in conformance with the boiler manufacturer's recommendations, the water treatment company shall take corrective action.

#### 3.5.1.2 Boiler/Piping Test

At the conclusion of the 1 year period, the boiler and condensate piping shall be inspected for problems due to corrosion and scale. If the boiler is found not to conform to the manufacturer's recommendations, and the water treatment company recommendations have been followed, the water treatment company shall provide all chemicals and labor for cleaning or repairing the equipment as required by the manufacturer's recommendations.

### 3.6 CLEANING

#### 3.6.1 Boilers and Piping

After the hydrostatic tests have been made and before the system is balanced and operating tests are performed, the boilers and feed water piping shall be thoroughly cleaned by filling the system with a solution consisting of either 0.5 kg of caustic soda or 0.5 kg of trisodium phosphate per 100 L of water. The proper safety precautions shall be observed in the handling and use of these chemicals. The water shall be heated to approximately 65 degrees C and the solution circulated in the system for a period of 48 hours. The system shall then be drained and thoroughly flushed out with fresh water. Strainers and valves shall be thoroughly cleaned. Prior to operating tests, air shall be removed from all water systems by operating the air vents.

#### 3.6.2 Heating Units

Inside space heating equipment, ducts, plenums, and casing shall be thoroughly cleaned of debris and blown free of small particles of rubbish and dust and then vacuum cleaned before installing outlet faces. Equipment shall be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. Temporary filters shall be provided for fans that are operated during construction, and new filters shall be installed after construction dirt has been removed from the building, and the ducts, plenum, casings, and other items specified have been vacuum cleaned. System shall be maintained in this clean condition until final acceptance. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions.

### 3.7 FUEL SYSTEM TESTS

#### 3.7.1 Gas System Test

The gas fuel system shall be tested in accordance with the test procedures outlined in NFPA 54.

### 3.8 FIELD TRAINING

The Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total of 4 hours of normal working time and shall start after the system is functionally completed but prior to final acceptance tests. The field instructions shall cover all of the items contained in the operating and maintenance instructions, as well as demonstrations of routine maintenance operations and boiler safety devices. The Contracting Officer shall be notified at least 14 days prior to date of proposed conduction of the training course.

## SECTION 15650

## CENTRAL REFRIGERATED AIR-CONDITIONING SYSTEM

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ARI ANSI/ARI 550	(1992) Centrifugal or Rotary Screw Water-Chilling Packages
ARI 575	(1994) Method of Measuring Machinery Sound Within an Equipment Space
ARI ANSI/ARI 590	(1992) Positive Displacement Compressor Water-Chilling Packages
ARI 700	(1995) Specifications for Fluorocarbon and Other Refrigerants
ARI ANSI/ARI 710	(1986) Liquid-Line Driers
ARI ANSI/ARI 720	(1988) Refrigerant Access Valves and Hose Connectors
ARI 750	(1994) Thermostatic Refrigerant Expansion Valves
ARI 760	(1994) Solenoid Valves for Use with Volatile Refrigerants

## AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABEMA)

ABEMA Std 9	(1990) Load Ratings and Fatigue Life for Ball Bearings
ABEMA Std 11	(1990) Load Ratings and Fatigue Life for Roller Bearings

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 47	(1990; R 1995) Ferritic Malleable Iron Castings
ASTM A 53	(1996) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 106	(1995) Seamless Carbon Steel Pipe for High-Temperature Service

ASTM A 181/A181M	(1995b) Carbon Steel Forgings for General-Purpose Piping
ASTM A 183	(1983; R 1990) Carbon Steel Track Bolts and Nuts
ASTM A 193/A193M	(1996) Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A 234/A234M	(1996b) Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM A 307	(1994) Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 334/A334M	(1996) Seamless and Welded Carbon and Alloy-Steel Tubes for Low-Temperature Service
ASTM A 536	(1984; R 1993) Ductile Iron Castings
ASTM A 733	(1993) Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM B 32	(1996) Solder Metal
ASTM B 62	(1993) Composition Bronze or Ounce Metal Castings
ASTM B 75	(1995a) Seamless Copper Tube
ASTM B 88	(1996) Seamless Copper Water Tube
ASTM B 117	(1995) Operating Salt Spray (Fog) Apparatus
ASTM B 280	(1995a) Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
ASTM D 520	(1984; R 1995) Zinc Dust Pigment
ASTM D 1384	(1996) Corrosion Test for Engine Coolants in Glassware
ASTM D 2000	(1996) Rubber Products in Automotive Applications
ASTM D 3308	(1991a) PTFE Resin Skived Tape
ASTM E 84	(1996a) Surface Burning Characteristics of Building Materials
ASTM F 104	(1993) Nonmetallic Gasket Materials
ASTM F 1199	(1988, R 1993) Cast (All Temperature and Pressures) and Welded Pipe Line Strainers (150 psig and 150 degrees F Maximum)

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING  
ENGINEERS (ASHRAE)

- ASHRAE 15 (1994) Safety Code for Mechanical Refrigeration
- ASHRAE 34 (1992; Addenda a-j) Number Designation and Safety Classification of Refrigerants

## AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

- ASME B1.20.1 (1983; R 1992) Pipe Threads, General Purpose (Inch)
- ASME B16.5 (1996) Pipe Flanges and Flanged Fittings NPS 1/2 thru NPS 24
- ASME B16.9 (1993) Factory-Made Wrought Steel Buttwelding Fittings
- ASME B16.11 (1991) Forged Fittings, Socket-Welding and Threaded
- ASME B16.18 (1984; R 1994) Cast Copper Alloy Solder Joint Pressure Fittings
- ASME B16.21 (1992) Nonmetallic Flat Gaskets for Pipe Flanges
- ASME B16.22 (1995) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
- ASME B16.26 (1988) Cast Copper Alloy Fittings for Flared Copper Tubes
- ASME B16.39 (1986; R 1994) Malleable Iron Threaded Pipe Unions Classes 150, 250, and 300
- ASME B31.1 (1995; B31.1a; B31.1b) Power Piping
- ASME B31.5 (1992; B31.5a) Refrigeration Piping
- ASME B40.1 (1991) Gauges - Pressure Indicating Dial Type - Elastic Element
- ASME BPV VIII Div 1 (1995; Addenda Dec 1995, Dec 1996) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage
- ASME BPV IX (1995; Addenda Dec 1995, Dec 1996) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications

## AMERICAN WATER WORKS ASSOCIATION (AWWA)

- AWWA C606 (1987) Grooved and Shouldered Joints

## AMERICAN WELDING SOCIETY (AWS)

AWS A5.8 (1992) Filler Metals for Brazing and Braze Welding

AWS D1.1 (1996) Structural Welding Code - Steel

## MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25 (1993) Standard Marking System for Valves, Fittings, Flanges and Unions

MSS SP-58 (1993) Pipe Hangers and Supports - Materials, Design and Manufacture

MSS SP-67 (1995) Butterfly Valves

MSS SP-69 (1996) Pipe Hangers and Supports - Selection and Application

MSS SP-70 (1990) Cast Iron Gate Valves, Flanged and Threaded Ends

MSS SP-71 (1990) Cast Iron Swing Check Valves, Flanges and Threaded Ends

MSS SP-72 (1992) Ball Valves with Flanged or Butt-Welding Ends for General Service

MSS SP-78 (1987; R 1992) Cast Iron Plug Valves, Flanged and Threaded Ends

MSS SP-80 (1997) Bronze Gate, Globe, Angle and Check Valves

MSS SP-85 (1994) Cast Iron Globe & Angle Valves, Flanged and Threaded Ends

MSS SP-110 (1996) Ball Valves Threaded, Socket Welding, Solder Joint, Grooved and Flared Ends

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1 (1993) Industrial Controls and Systems

NEMA ICS 2 (1993) Industrial Control and Systems Controllers, Contractors, and Overload Relays Rated Not More Than 2,000 Volts AC or 750 DC

NEMA MG 1 (1993; Rev 1; Rev 2; Rev 3) Motors and Generators

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A

(1996; Errata) Installation of Air  
Conditioning and Ventilating Systems

## 1.2 SYSTEM DESCRIPTION

This specification section covers the provisions and installation procedures necessary for a complete and totally functional central refrigerated air-conditioning system as defined herein.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

SD-01 Data

Central Refrigerated Air-Conditioning System; GA.

Manufacturer's catalog data, at least 8 weeks prior to beginning construction, shall be highlighted to show model No., size, options, performance charts and curves, etc. in adequate detail to demonstrate compliance with contract requirements. Data shall include manufacturer's recommended installation instructions and procedures. Data shall be adequate to demonstrate compliance with contract requirements as specified within the paragraphs:

- a. Refrigeration System
- b. System Components
- c. Accessories
- d. Piping Components

If vibration isolation is specified for a unit, vibration isolator literature shall be included containing catalog cuts and certification that the isolation characteristics of the isolators provided meet the manufacturer's recommendations.

Water Treatment Systems; GA.

Six complete copies, at least 5 weeks prior to the purchase of the water treatment system, of the proposed water treatment plan including a layout, control scheme, a list of existing make-up water conditions including the items listed in Paragraph Water Analysis, a list of chemicals, the proportion of chemicals to be added, the final treated water conditions, and a description of environmental concerns for handling the chemicals.

Spare Parts; FIO.

Spare parts data for each different item of material and equipment specified, after approval of the detail drawings and not later than 3 months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with source of supply.



Qualifications; FIO.

6 copies of qualified procedures, and list of names and identification symbols of qualified welders and welding operators, prior to non-factory welding operations.

#### SD-04 Drawings

Central Refrigerated Air-Conditioning System ; GA.

Drawings, at least 8 prior to beginning construction, shall provide adequate detail to demonstrate compliance with contract requirements. Drawings shall consist of:

- a. Equipment layouts which identify assembly and installation details.
- b. Piping layouts which identify all valves and fittings.
- c. Plans and elevations which identify clearances required for maintenance and operation.
- d. Wiring diagrams which identify each component individually and all interconnected or interlocked relationships between components.
- e. Foundation drawings, bolt-setting information, and foundation bolts prior to concrete foundation construction for all equipment indicated or required to have concrete foundations.
- f. Details, if piping and equipment are to be supported other than as indicated, which include loadings and type of frames, brackets, stanchions, or other supports.

#### SD-06 Instructions

Posted Instructions; GA.

Posted instructions, at least 6 weeks prior to construction completion, shall include equipment layout, wiring and control diagrams, piping, valves and control sequences, and typed condensed operation instructions. The condensed operation instructions shall include preventative maintenance procedures, methods of checking the system for normal and safe operation, and procedures for safely starting and stopping the system. The posted instructions shall be framed under glass or laminated plastic and be posted where indicated by the Contracting Officer.

#### SD-07 Schedules

Tests; GA.

Test schedules, at least 4 weeks prior to the start of related testing, for each of the field tests and the system performance tests. The schedules shall identify the date, time, and location for each test.

Demonstrations; FIO.

A schedule, at least 4 weeks prior to the date of the proposed training course, which identifies the date, time, and location for the training.

## SD-08 Statements

Verification of Dimensions; GA.

A letter, at least 8 weeks prior to beginning construction, including the date the site was visited, conformation of existing conditions, and any discrepancies found.

## SD-09 Reports

Field Tests; GA.

Six copies of the report shall be provided in bound 216 x 279 mm booklets. Reports shall document all phases of tests performed during the Water Pipe Testing, the Refrigerant Pipe Testing, and the Cooling Tower Tests. The report shall include initial test summaries, all repairs/adjustments made, and the final test results.

System Performance Tests; GA.

Six copies of the report shall be provided in bound 216 x 279 mm booklets. The report shall document compliance with the specified performance criteria upon completion and testing of the system. The report shall indicate the number of days covered by the tests and any conclusions as to the adequacy of the system. The report shall also include the following information and shall be taken at least three different times at outside dry-bulb temperatures that are at least 3 degrees C apart:

- a. Date and outside weather conditions.
- b. The load on the system based on the following:
  - (1) The refrigerant used in the system.
  - (2) Condensing temperature and pressure.
  - (3) Suction temperature and pressure.
  - (4) Running current, voltage and proper phase sequence for each phase of all motors.
  - (5) The actual on-site setting of all operating and safety controls.
  - (6) Chilled water pressure, flow and temperature in and out of the chiller.
  - (7) The position of the capacity-reduction hardware, equipment and control logic output for capacity reduction at machine off, one-third loaded, one-half loaded, two-thirds loaded, and fully loaded.

Inspections; FIO.

Six copies of an inspection report, at the completion of one year of service, in bound 216 x 279 mm booklets. The report shall identify all

actions taken by the Contractor and manufacturer to correct deficiencies during the first year of service.

#### SD-13 Certificates

Central Refrigerated Air-Conditioning System; FIO.

Where the system, components, or equipment are specified to comply with requirements of AGA, NFPA, ARI, ASHRAE, ASME, or UL, 2 copies of proof of such compliance shall be provided. The label or listing of the specified agency shall be acceptable evidence. In lieu of the label or listing, a written certificate from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency may be submitted. When performance requirements of this project's drawings and specifications vary from standard ARI rating conditions, computer printouts, catalog, or other application data certified by ARI or a nationally recognized laboratory as described above shall be included. If ARI does not have a current certification program that encompasses such application data, the manufacturer may self certify that his application data complies with project performance requirements in accordance with the specified test standards.

#### SD-19 Operation and Maintenance Manuals

Operation Manual; GA.

Six complete copies of an operation manual in bound 216 x 279 mm booklets listing step-by-step procedures required for system startup, operation, abnormal shutdown, emergency shutdown, and normal shutdown at least 4 weeks prior to the first training course. The booklets shall include the manufacturer's name, model number, and parts list. The manuals shall include the manufacturer's name, model number, service manual, and a brief description of all equipment and their basic operating features.

Maintenance Manual; GA.

Six complete copies of maintenance manual in bound 216 x 279 mm booklets listing routine maintenance procedures, possible breakdowns and repairs, and a trouble shooting guide. The manuals shall include piping and equipment layouts and simplified wiring and control diagrams of the system as installed.

Water Treatment System; FIO.

Six complete copies of operating and maintenance manuals for the step-by-step water treatment procedures. The manuals shall include testing procedures used in determining water quality.

### 1.4 QUALIFICATIONS

Piping shall be welded in accordance with the qualified procedures using performance qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPV IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified 24 hours in advance of tests and the tests shall

be performed at the work site if practical. The welder or welding operator shall apply his assigned symbol near each weld he makes as a permanent record. Structural members shall be welded in accordance with Section 05055 WELDING, STRUCTURAL.

#### 1.5 SAFETY REQUIREMENTS

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Safety devices shall be installed so that proper operation of equipment is not impaired.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

All equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

#### 1.7 PROJECT/SITE CONDITIONS

##### 1.7.1 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

##### 1.7.2 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and shall arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions.

#### 2 PRODUCTS

##### 2.1 STANDARD COMMERCIAL PRODUCTS

Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for two years prior to bid opening. The two-year use shall include applications of equipment and materials under similar circumstances and of similar size. The two years experience shall be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a two-year field service record shall be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. All products shall be supported by a service organization. The Contractor shall submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations shall be reasonably convenient to the equipment installation and shall be

able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

## 2.2 NAMEPLATES

Each major component of equipment shall have the manufacturer's name, address, type or style, and catalog or serial number on a plate securely attached to the item of equipment. As a minimum, nameplates shall be provided for:

- a. Liquid-Chilling Packages
- b. Compressors
- c. Compressor Drivers
- d. Liquid Coolers
- e. Pumps
- f. Pump Motors
- g. Expansion Tanks
- h. Air Separator Tanks
- i. ASME Chilled Water Storage Tanks

## 2.3 ELECTRICAL WORK

Electrical equipment, motors, motor starters, and wiring shall be in accordance with Section 16415 ELECTRICAL WORK, INTERIOR. Electrical motor driven equipment specified shall be provided complete with motors, motor starters, and controls. Electrical characteristics and enclosure type shall be as shown, and unless otherwise indicated, all motors of 745 W and above with open, dripproof, or totally enclosed fan cooled enclosures, shall be high efficiency type. Field wiring shall be in accordance with manufacturer's instructions. Each motor shall conform to NEMA MG 1 and be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Motors shall be continuous duty with the enclosure specified. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary for the motor control indicated. Motors shall be furnished with a magnetic across-the-line or reduced voltage type starter as required by the manufacturer. Motor starter shall be provided in enclosures constructed in accordance with UL and NEMA 1 enclosures. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, shall be provided.

## 2.4 PACKAGED AIR-COOLED LIQUID CHILLERS

Unless necessary for delivery purposes, units shall be assembled, leak-tested, charged (refrigerant and oil), and adjusted at the factory. In lieu of delivery constraints, a chiller may be assembled, leak-tested, charged (refrigerant and oil), and adjusted at the job site by a factory representative. Unit components delivered separately shall be sealed and charged with a nitrogen holding charge. Unit assembly shall be completed in strict accordance with manufacturer's recommendations. Chiller shall operate within capacity range and speed recommended by the manufacturer. Parts weighing 23 kg or more which must be removed for inspection, cleaning, or repair, such as motors, gear boxes, cylinder heads, casing tops, condenser, and cooler heads, shall have lifting eyes or lugs. Chiller shall be provided with factory installed insulation on surfaces subject to sweating including the liquid cooler, suction line piping, economizer, and

cooling lines. Chiller shall include all customary auxiliaries deemed necessary by the manufacturer for safe, controlled, automatic operation of the equipment. Chiller shall be provided with a single point wiring connection for incoming power supply. Factory installed insulation shall be provided on all suction piping from the evaporator to the compressor and on the liquid cooler shell. Where motors are the gas-cooled type, factory installed insulation shall be provided on the cold-gas inlet connection to the motor per manufacturer's standard practice. Chiller's liquid cooler shall be provided with standard water boxes with flanged connections.

#### 2.4.1 Scroll, Reciprocating, or Rotary Screw Type

Chiller shall be constructed and rated in accordance with ARI ANSI/ARI 590. Chiller shall conform to ASHRAE 15. Chiller shall have a minimum full load COP rating as shown in accordance with ARI ANSI/ARI 590. As a minimum, chiller shall include the following components as defined in paragraph CHILLER COMPONENTS.

- a. Refrigerant and oil
- b. Structural base
- c. Controls package
- d. Scroll, reciprocating, or rotary screw compressor
- e. Compressor driver, electric motor
- f. Compressor driver connection
- g. Liquid cooler (evaporator)
- f. Air condenser coil
- g. Tools
- h. Chiller refrigerant circuit

#### 2.4.2 Rotary Screw Type

Rotary screw chiller shall be constructed and rated in accordance with ARI ANSI/ARI 550 or ARI ANSI/ARI 590 as applicable. Chiller shall have a minimum full load COP rating as shown. Chiller shall conform to ASHRAE 15. As a minimum, chiller shall include the following components as defined in paragraph CHILLER COMPONENTS.

- a. Refrigerant and oil
- b. Structural base
- c. Controls package
- d. Rotary screw compressor
- e. Compressor driver, electric motor
- f. Compressor driver connection
- g. Liquid cooler (evaporator)
- h. Air cooled condenser coil
- j. Purge system for chillers which operate below atmospheric pressure
- k. Tools

### 2.5 CHILLER COMPONENTS

#### 2.5.1 Refrigerant and Oil

Refrigerants shall be one of the fluorocarbon gases. Refrigerants shall have number designations and safety classifications in accordance with ASHRAE 34. Refrigerants shall meet the requirements of ARI 700 as a minimum. Refrigerants shall have an Ozone Depletion Potential (ODP) of less than or equal to 0.05.

### 2.5.2 Structural Base

Chiller and individual chiller components shall be provided with a factory-mounted welded structural steel base or support legs. Chiller and individual chiller components shall be isolated from the building structure by means of molded neoprene isolation pads. Vibration isolators shall have isolation characteristics as recommended by the manufacturer for the unit supplied and the service intended.

### 2.5.3 Chiller Refrigerant Circuit

Chiller refrigerant circuit shall be completely piped and factory leak tested. For multicompressor units, not less than 2 independent refrigerant circuits shall be provided. Circuit shall include as a minimum a combination filter and drier, combination sight glass and moisture indicator, liquid-line solenoid valve for reciprocating or scroll units, an electronic or thermostatic expansion valve with external equalizer, charging ports, compressor service valves, and superheat adjustment.

### 2.5.4 Controls Package

Chiller shall be provided with a complete factory mounted and prewired electric or microprocessor based control system. Controls package shall be unit-mounted which contains as a minimum a digital display or acceptable gauges, an on-auto-off switch, motor starters, power wiring, control wiring, and disconnect switches. Controls package shall provide operating controls, monitoring capabilities, programmable setpoints, safety controls, and EMCS interfaces as defined below. Chiller controls software and firmware shall be fully year 2000 compliant.

#### 2.5.4.1 Operating Controls

Chiller shall be provided with the following adjustable operating controls as a minimum.

- a. Leaving chilled water temperature control
- b. Adjustable timer to prevent compressor from short cycling
- c. Automatic lead/lag controls (adjustable) for multiprocessor units
- d. Load limiting
- e. Fan sequencing for air-cooled condenser
- f. System capacity control to adjust the unit capacity in accordance with the system load and the programmable setpoints. Controls shall automatically re-cycle the chiller on power interruption.
- g. Startup and head pressure controls to allow system operation at all ambient temperatures down to -6.7 degrees C.

#### 2.5.4.2 Monitoring Capabilities

During normal operations, the control system shall be capable of monitoring and displaying the following operating parameters. Access and operation of display shall not require opening or removing any panels or doors.

- a. Entering and leaving chilled water temperatures
- b. Self diagnostic
- c. Operation status
- d. Operating hours
- e. Number of starts
- f. Compressor status (on or off)
- g. Refrigerant discharge and suction pressures
- h. Condenser water entering and leaving temperatures
- j. Number of purge cycles over the last 7 days
- k. Alarm status and lockouts as well as stored alarms and lockouts
- l. Condenser fan status
- m. Leaving Chilled Water Setpoint

#### 2.5.4.3 Programmable Setpoints

The control system shall be capable of being reprogrammed directly at the unit. No parameters shall be capable of being changed without first entering a security access code. The programmable setpoints shall include the following as a minimum.

- a. Leaving Chilled Water Temperature
- c. Time Clock/Calendar Date

#### 2.5.4.4 Safety Controls with Manual Reset

Chiller shall be provided with the following safety controls which automatically shutdown the chiller and which require manual reset.

- a. Low chilled water temperature protection
- b. High condenser refrigerant discharge pressure protection
- c. Low suction pressure protection
- d. Chilled water flow detection
- e. Motor current overload and phase loss protection
- f. High motor winding temperature protection for hermetic motors
- g. Low oil flow protection

#### 2.5.4.5 Safety Controls with Automatic Reset

Chiller shall be provided with the following safety controls which automatically shutdown the chiller and which provide automatic reset.

- a. Over/under voltage protection
- b. Phase reversal protection
- c. Chilled water flow interlock

#### 2.5.4.6 Remote Alarm

During the initiation of a safety shutdown, the control system shall be capable of activating a remote alarm bell. In coordination with the chiller, the contractor shall provide an alarm circuit including transformer



if applicable and a minimum 100 mm diameter alarm bell. Alarm circuit shall activate bell in the event of machine shutdown due to the chiller's monitoring of safety controls. The alarm bell shall not sound for a chiller that uses low-pressure cutout as an operating control. The alarm bell shall be installed in the community building mechanical room next to one of the entry doors.

#### 2.5.4.7 Energy Management Control System (EMCS) Interface

The control system shall be capable of communicating all data to a remote integrated DDC processor through a single shielded cable. The data shall include as a minimum all system operating conditions, capacity controls, and safety shutdown conditions. The control system shall also be capable of receiving at a minimum the following operating commands. An interface circuit board shall be provided by the chiller manufacturer in the chiller control panel; the interface board shall be capable and compatible with the postwide Williams Electric Company EMCS. The interface board shall pass and receive all data and commands as shown herein and on the contract drawings.

- a. Remote Unit Start/Stop
- b. Remote Chilled Water Reset
- c. Electrical demand limit
- d. Unit Enable/Disable
- e. Unit Alarms and Unit status

#### 2.5.5 Compressor(s)

##### 2.5.5.1 Reciprocating Compressor(s)

All rotating parts shall be statically and dynamically balanced at the factory to minimize vibration. Compressors shall be capable of operating at partial-load conditions without increased vibration over the normal vibration at full load operation and shall be capable of continuous operation down to the lowest step of unloading as specified. Compressors of size 7.45 kW and above shall have an oil lubrication system of the reversible, forced-feed type with oil strainer. Shaft seal in open-type units shall be mechanical type. Piston speed for open-type compressors shall not exceed the manufacturer's recommendation or 6 m/s, whichever is less. Compressors shall include:

- a. Vertical, V, W, or radial cylinder design
- b. Oil lubrication
- c. Integrally cast block of close-grained iron or cast aluminum block with hardened steel cylinder sleeves
- d. Oil-level bull's eye
- e. Cast cylinder heads
- f. Cast-aluminum or forged-steel connecting rods
- g. Cast iron or forged-steel crankshaft
- h. Main bearings of the sleeve-insert type

- i. Crankcase oil heaters controlled as recommended by the manufacturer
- j. Suction and discharge refrigerant service valves that are flange connected, wrench operated, with cap
- k. A strainer on the suction side of the compressor
- l. A hot-gas muffler to reduce vibration and noise from pulsations

#### 2.5.5.2 Scroll Compressor(s)

Compressors shall be of the compliant, hermetically sealed design. Compressors shall be mounted on vibration isolators to minimize vibration and noise. Rotating parts shall be statically and dynamically balanced at the factory to minimize vibration. Lubrication system shall be centrifugal pump type equipped with a means for determining oil level and an oil charging valve. Crankcase oil heater shall be provided if standard or if available as an option. If provided, the crankcase oil heater shall be controlled as recommended by the manufacturer.

#### 2.5.5.3 Rotary Screw Compressor(s)

Compressors shall operate stably for indefinite time periods at any stage of capacity reduction without hot-gas bypass. Provision shall be made to insure proper lubrication of bearings and shaft seals on shutdown with or without electric power supply. Rotary screw compressors shall include:

- a. An open or hermetic, positive displacement, oil-injected design directly driven by the compressor driver. Compressor shall allow access to internal compressor components for repairs, inspection, and replacement of parts.
- b. Rotors which are solid steel forging with sufficient rigidity for proper operation.
- c. A maximum rotor operating speed no greater than 3600 RPM.
- d. Casings of cast iron, precision machined for minimal clearance about periphery of rotors.
- e. A lubrication system of the forced-feed type that provides oil at the proper pressure to all parts requiring lubrication.
- f. Shaft main bearings of the sleeve type with heavy duty bushings or rolling element type in accordance with ABEMA Std 9 or ABEMA Std 11. Bearings shall be conservatively loaded and rated for an L(10) life of not less than 200,000 hours.
- g. A differential oil pressure or flow cutout to allow the compressor to operate only when the required oil pressure or flow is provided to the bearings.
- h. A temperature- or pressure-initiated, hydraulically actuated, single-slide-valve, capacity-control system to provide minimum automatic capacity modulation from 100 percent to 25 percent.

- i. An oil separator and oil return system to remove oil entrained in the refrigerant gas and automatically return the oil to the compressor.
- j. Crankcase oil heaters controlled as recommended by the manufacturer.

#### 2.5.6 Compressor Driver, Electric Motor

Motor shall be the polyphase, induction type conforming to NEMA MG 1. Motors shall be suitable for use with the indicated electrical power characteristics and the type of starter provided. Motor starters shall be the reduced voltage, closed-transition type conforming to NEMA ICS 1 and NEMA ICS 2. Motor starter shall be unit mounted as indicated with starter type, wiring, and accessories coordinated by the chiller manufacturer. Starter shall be able to operate in temperatures up to 120 degrees F.

#### 2.5.7 Compressor Driver Connections

Each compressor shall be driven by a V-belt drive or direct connected through a flexible coupling, except that flexible coupling is not required on hermetic units. V-belt drives shall be designed for not less than 150 percent of the driving motor capacity. Flexible couplings shall be of the type that does not require lubrication. Each machine driven through speed-increasing gears shall be so designed as to assure self-alignment, interchangeable parts, proper lubrication, and minimum of unbalanced forces. Bearings shall be of the sleeve or roller type. Pressure lubrication with pump and cooler shall be provided. Gear cases shall be oil tight. Shaft extensions shall be provided with seals to retain oil and exclude all dust.

#### 2.5.8 Liquid Cooler (Evaporator)

Cooler shall be of the shell-and-coil or shell-and-tube type design. Condenser's refrigerant side shall be designed and factory pressure tested to comply with ASHRAE 15. Condenser's water side shall be designed and factory pressure tested for not less than 1,000 kPa. Cooler shell shall be constructed of seamless or welded steel. Coil bundles shall be totally removable and arranged to drain completely. Tubes shall be seamless copper, plain, integrally finned with smooth bore or integrally finned with enhanced bore. Each tube shall be individually replaceable. Tubes shall be installed into carbon mild steel tube sheets by rolling. Tube baffles shall be properly spaced to provide adequate tube support and cross flow. Performance shall be based on a water velocity not less than 0.91 m/s nor more than 3.7 mm and a fouling factor of 0.00025.

#### 2.5.9 Air-Cooled Condenser Coil

Condenser coil shall be of the extended-surface fin-and-tube type and shall be constructed of seamless copper tubes with compatible copper fins. Fins shall be soldered or mechanically bonded to the tubes and installed in a metal casing. Coils shall be circuited and sized for a minimum of 3 degrees C subcooling and full pumpdown capacity. Coil shall be factory leak and pressure tested after assembly in accordance with ASHRAE 15.

#### 2.5.10 Tools

One complete set of special tools as recommended by the manufacturer for field maintenance of the system shall be provided. Tools shall be mounted on a tool board in the equipment room or contained in a toolbox as directed by the Contracting Officer.

### 2.6 ACCESSORIES

#### 2.6.1 Pumps

Pumps shall be as specified in Section 11211 and be the electrically driven, non-overloading, horizontal split-case centrifugal type which conform to HI-01.

#### 2.6.2 Chilled Water Storage Tanks

Tanks shall be welded steel, constructed, tested and stamped in accordance with ASME BPV VIII Div 1 for a working pressure of 862 kPa. The tank shall be equipped with the number of nozzles shown. Tank support shall be atop equipment pads and structural support as shown; Tanks shall come read for installation atop equipment pads or structural frames as shown. Submit installation details and drawings for structural approval.

#### 2.6.3 Expansion Tanks

Expansion tanks shall be welded steel, constructed, tested and stamped in accordance with ASME BPV VIII Div 1 for a working pressure of 862 kPa and precharged to the minimum operating pressure. Expansion tanks shall have a replaceable diaphragm and be the captive air type. Tanks shall accommodate expanded water of the system generated within the normal operating temperature range, limiting this pressure increase at all components in the system to the maximum allowable pressure at those components. Each tank air chamber shall be fitted with an air charging valve. Tanks shall be supported by steel legs or bases for vertical installation or steel saddles for horizontal installations. The only air in the system shall be the permanent sealed-in air cushion contained within the expansion tank.

#### 2.6.4 Air Separator Tanks

External air separation tank shall be steel, constructed, tested, and stamped in accordance with ASME BPV VIII Div 1 for a working pressure of 862 kPa.

#### 2.6.5 Signs

Metal signs shall be provided having letters not less than 12 mm in height designating the main shut-off valves to each refrigerant vessel, the electrical control of the chiller, and the pressure limiting device.

#### 2.6.6 Gaskets

Gaskets shall conform to ASTM F 104 - classification for compressed sheet with nitrile binder and acrylic fibers for maximum 371 degrees C (700 degrees F) service.

### 2.6.7 Bolts and Nuts

Bolts and nuts, except as required for piping applications, shall be in accordance with ASTM A 307. The bolt head shall be marked to identify the manufacturer and the standard with which the bolt complies in accordance with ASTM A 307.

## 2.7 WATER TREATMENT SYSTEMS

When water treatment is specified, the use of chemical-treatment products containing hexavalent chromium (Cr) is prohibited.

### 2.7.1 Water Analysis

Conditions of make-up water to be supplied to the chilled water systems are as follows: Obtain a current water chemical analysis from the Contracting Officers Representative.

### 2.7.2 Chilled Water

Water to be used in the chilled system shall be treated to maintain the conditions recommended by this specification as well as the recommendations from the manufacturers of the evaporator. Chemicals shall meet all required federal, state, and local environmental regulations for the treatment of evaporators and direct discharge to the sanitary sewer.

### 2.7.3 Glycol Solution

Industrial grade ethylene and propylene glycol shall be provided for the Community building 1 and Community Building 2 systems, respectively in the percentage shown. The glycol shall be tested in accordance with ASTM D 1384 with less than 0.013 mm penetration per year for all system metals. The glycol shall contain corrosion inhibitors. Silicate based inhibitors shall not be used. The solution shall be compatible with pump seals, other elements of the system, and water treatment chemicals used within the system.

### 2.7.4 Chilled Water System

A chemical filter/feeder system shall be provided on the chilled water piping as indicated. The feeder shall be furnished with an air vent, gauge glass, funnel, valves, fittings, and piping as shown.

## 2.8 PIPING COMPONENTS

### 2.8.1 Water Piping and Fittings

#### 2.8.1.1 Steel Pipe

Steel pipe shall conform to ASTM A 53, Schedule 40, Type E or S, Grades A or B. Type F pipe shall not be used.

#### 2.8.1.2 Steel Pipe Joints and Fittings

Joints and fittings shall be welded, flanged, threaded, or grooved as indicated. If not otherwise indicated, piping 25 mm and smaller shall be threaded; piping larger than 25 mm and smaller than 80 mm shall be either

threaded, grooved, or welded; and piping 80 mm and larger shall be grooved, welded, or flanged. Rigid grooved mechanical joints and fittings may only be used in serviceable aboveground locations where the temperature of the circulating medium does not exceed 110 degrees C. Flexible grooved joints shall be used only as a flexible connector with grooved pipe system. Unless otherwise specified, grooved piping components shall meet the corresponding criteria specified for the similar welded, flanged, or threaded component specified herein. The manufacturer of each fitting shall be permanently identified on the body of the fitting in accordance with MSS SP-25.

- a. Welded Joints and Fittings: Welded fittings shall conform to ASTM A 234/A234M, and identified with the appropriate grade and marking symbol. Butt-welding fittings shall conform to ASME B16.9. Socket-welding and threaded fittings shall conform to ASME B16.11.
- b. Flanged Joints and Fittings: Flanges shall conform to ASTM A 181/A181M and ASME B16.5 Class 150. Gaskets shall be nonasbestos compressed material in accordance with ASME B16.21, 1.59 mm thickness, full face or self-centering flat ring type. This gaskets shall contain aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR). Bolts, nuts, and bolt patterns shall conform to ASME B16.5. Bolts shall be high or intermediate strength material conforming to ASTM A 193/A193M.
- c. Threaded Joints and Fittings: Threads shall conform to ASME B1.20.1. Pipe nipples shall conform to ASTM A 733, type and material to match adjacent piping. Unions shall conform to ASME B16.39, type as required to match adjacent piping.
- d. Dielectric Unions and Flanges: Dielectric unions shall have the tensile strength and dimensional requirements specified. Unions shall have metal connections on both ends threaded to match adjacent piping. Metal parts of dielectric unions shall be separated with a nylon insulator to prevent current flow between dissimilar metals. Unions shall be suitable for the required operating pressures and temperatures. Dielectric flanges shall provide the same pressure ratings as standard flanges and provide complete electrical isolation.
- e. Grooved Mechanical Joints and Fittings: Joints and fittings shall be designed for not less than 862 kPa service and shall be the product of the same manufacturer. Fitting and coupling houses shall be malleable iron conforming to ASTM A 47, Grade 32510; ductile iron conforming to ASTM A 536, Grade 65-45-12; or steel conforming ASTM A 106, Grade B or ASTM A 53. Gaskets shall be molded synthetic rubber with central cavity, pressure responsive configuration and shall conform to ASTM D 2000 Grade No. 2CA615A15B44F17Z for circulating medium up to 110 degrees C or Grade No. M3BA610A15B44Z for circulating medium up to 93 degrees C. Grooved joints shall conform to AWWA C606. Coupling nuts and bolts shall be steel and shall conform to ASTM A 183.

#### 2.8.1.3 Copper Tube

Copper tubing for water service shall conform to ASTM B 88, Type K or L.

#### 2.8.1.4 Copper Tube Joints and Fittings

Wrought copper and bronze solder-joint pressure fittings shall conform to ASME B16.22 and ASTM B 75. Cast copper alloy solder-joint pressure fittings shall conform to ASME B16.18. Cast copper alloy fittings for flared copper tube shall conform to ASME B16.26 and ASTM B 62. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment. Extracted brazed tee joints produced with an acceptable tool and installed as recommended by the manufacturer may be used.

#### 2.8.2 Water Piping Valves and Accessories

Valves shall be rated for Class 125 and shall be suitable for operating temperature of 120 degrees C. Valves shall be suitable for the working pressure of the pipe in which installed. Valves shall meet the material, fabrication and operating requirements of ASME B31.1. Chain operators shall be provided for valves located 3 m or higher above the floor. Valves in sizes larger than 25 mm and used on steel pipe systems, may be provided with rigid grooved mechanical joint ends. Such grooved end valves shall be subject to the same requirements as rigid grooved mechanical joints and fittings and, shall be provided by the same manufacturer as the grooved pipe joint and fitting system.

##### 2.8.2.1 Gate Valves

Gate valves 65 mm and smaller shall conform to MSS SP-80 and shall be bronze with rising stem and threaded, soldered, or flanged ends. Gate valves 80 mm and larger shall conform to MSS SP-70, Type I, II, Class 125, Design OF and shall be cast iron with bronze trim, outside screw and yoke, and flanged or threaded ends.

##### 2.8.2.2 Globe and Angle Valves

Globe and angle valves 65 mm and smaller shall conform to MSS SP-80 and shall be bronze with threaded, soldered, or flanged ends. Globe and angle valves 80 mm and larger shall conform to MSS SP-85 and shall be cast iron with bronze trim and flanged or threaded ends.

##### 2.8.2.3 Check Valves

Check valves 65 mm and smaller shall conform to MSS SP-80 and shall be bronze with threaded, soldered, or flanged ends. Check valves 80 mm and larger shall conform to MSS SP-71, Type I, II, III, or IV, Class 125 or 150 and shall be cast iron with bronze trim and flanged or threaded ends.

##### 2.8.2.4 Butterfly Valves

Butterfly valves shall be in accordance with MSS SP-67, Type 1 and shall be 2 flange or lug wafer type, and shall be bubble tight at 1,000 kPa. Valve bodies shall be cast iron, malleable iron, or steel. Valves smaller than 200 mm shall have throttling handles with a minimum of seven locking positions. Valves 200 mm and larger shall have totally enclosed manual gear operators with adjustable balance return stops and position indicators. Valves in insulated lines shall have extended neck to accommodate insulation thickness.

#### 2.8.2.5 Plug Valves

Plug valves 50 mm and larger shall conform to MSS SP-78, have flanged or threaded ends, and have cast iron bodies with bronze trim. Valves 50 mm and smaller shall be bronze with NPT connections for black steel pipe and brazed connections for copper tubing. Valves shall be lubricated, non-lubricated, or tetrafluoroethylene resin-coated type. Valves shall be resilient, double seated, trunnion mounted with tapered lift plug capable of 2-way shutoff. Valves shall operate from fully open to fully closed by rotation of the handwheel to lift and turn the plug. Valves shall have weatherproof operators with mechanical position indicators. Valves 200 mm or larger shall be provided with manual gear operators with position indicators.

#### 2.8.2.6 Ball Valves

Ball valves 15 mm and larger shall conform to MSS SP-72 or MSS SP-110 and shall be ductile iron or bronze with threaded, soldered, or flanged ends. Valves 200 mm or larger shall be provided with manual gear operators with position indicators.

#### 2.8.2.7 Calibrated Balancing Valves

Each valve shall be calibrated so that flow can be determined when the temperature and pressure differential across valve is known. Valves shall have an integral pointer which registers the degree of valve opening. Each valve shall be constructed with internal seals to prevent leakage and shall be supplied with preformed insulation. Valves Cv rating shall be as indicated. Valve bodies shall be provided with tapped openings and pipe extensions with positive shutoff valves outside of pipe insulation. The pipe extensions shall be provided with quick connecting hose fittings for a portable meter to measure the pressure differential. **One portable differential meter, suitable for the operating pressure specified, shall be provided and shall become the property of the Government.** The meter shall be complete with hoses, vent, integral metering connections, and carrying case as recommended by the valve manufacturer.

#### 2.8.2.8 Air Vents

Manual air vents shall be brass or bronze valves or cocks suitable for 862 kpa service, and furnished with threaded plugs or caps. Automatic air vents shall be float type, cast iron, stainless steel, or forged steel construction, suitable for 862 kpa service.

#### 2.8.2.9 Strainers

Strainers shall be in accordance with ASTM F 1199, except as modified herein. Strainer shall be the cleanable, basket or "Y" type, the same size as the pipeline. The strainer bodies shall be fabricated of cast iron with bottoms drilled, and tapped. The bodies shall have arrows clearly cast on the sides indicating the direction of flow. Each strainer shall be equipped with removable cover and sediment screen. The screen shall be made of minimum 0.8 mm brass sheet, with small perforations numbering not less than 60 per square centimeter to provide a net free area through the basket of at least 3.30 times that of the entering pipe. The flow shall be into the screen and out through the perforations.



#### 2.8.2.10 Combination Strainer and Suction Diffuser

A combination strainer and suction diffuser, consisting of an angle type body with removable strainer basket and straightening vanes, a suction pipe support, and a blowdown outlet, shall be provided on pump suction. The combination strainer and suction diffuser shall be in accordance with ASTM F 1199, except as modified herein.

#### 2.8.2.11 Pump Discharge Valves

Pump discharge valves shall be installed where indicated and shall perform the functions of a nonslam check valve, a manual balancing valve, and a shutoff. Valves shall be of cast iron or ductile iron construction with bronze and/or stainless steel accessories. Valves shall have an integral pointer which registers the degree of valve opening. Flow through the valve shall be manually adjustable from bubble tight shutoff to full flow. Valves smaller than 50 mm shall have NPT connections. Valves 50 mm and larger shall have flanged or grooved end connections. The valve design shall allow the back seat for the stem to be replaced in the field under full line pressure. Valve Cv rating shall be as indicated.

#### 2.8.2.12 Backflow Preventers

Backflow preventers shall be in accordance with Section 15400 PLUMBING, GENERAL PURPOSE.

#### 2.8.2.13 Flexible Pipe Connectors

Flexible pipe connectors shall be designed for 862 kPa or 1034 kPa service as appropriate for the static head plus the system head, and 120 degrees C, for grooved end flexible connectors. The flexible section shall be constructed of rubber, tetrafluoroethylene resin, or corrosion-resisting steel, bronze, monel, or galvanized steel. The flexible section shall be suitable for intended service with end connections to match adjacent piping. Flanged assemblies shall be equipped with limit bolts to restrict maximum travel to the manufacturer's standard limits. Unless otherwise indicated, the length of the flexible connectors shall be as recommended by the manufacturer for the service intended. Internal sleeves or liners, compatible with circulating medium, shall be provided when recommended by the manufacturer. Covers to protect the bellows shall be provided where indicated.

#### 2.8.2.14 Pressure Gauges

Gauges shall conform to ASME B40.1 and shall be provided with throttling type needle valve or a pulsation dampener and shut-off valve. Gauge shall be a minimum of 85 mm in diameter with a range from 0 kPa to approximately 1.5 times the maximum system working pressure.

#### 2.8.2.15 Thermometers

Thermometers shall have brass, malleable iron, or aluminum alloy case and frame, clear protective face, permanently stabilized glass tube with indicating-fluid column, white face, black numbers, and a 225 mm scale. Thermometers shall have rigid stems with straight, angular, or inclined pattern.

#### 2.8.2.16 Pipe Nipples

Pipe nipples shall be in accordance with ASTM A 733 and be of material to match adjacent piping.

#### 2.8.2.17 Pipe Unions

Pipe unions shall be in accordance with ASME B16.39 and be of material to match adjacent piping.

#### 2.8.2.18 Solder

Solder for water piping shall be in accordance with ASTM B 32, alloy grade 50B.

### 2.8.3 Refrigerant Piping and Fittings

Refrigerant piping, valves, fittings, and accessories shall conform to the requirements of ASHRAE 15 and ASME B31.5, except as specified.

#### 2.8.3.1 Steel Pipe

Steel pipe for refrigerant service shall conform to ASTM A 53, Schedule 40, Type E or S, Grades A or B. Type F pipe shall not be used.

#### 2.8.3.2 Steel Pipe Joints and Fittings

Joints and fittings shall be steel butt-welding, socket-welding, or malleable iron threaded type. Pipe shall be welded except that joints on lines 50 mm and smaller may be threaded. Threads shall be tapered type conforming to ASME B1.20.1. The malleable iron threaded type fitting shall be of a weight corresponding to adjacent pipe. Flanges and flange faces of fittings shall be tongue-and-groove type with gaskets suitable for the refrigerant used; size 25 mm and smaller shall be oval, two-bolt type; size above 25 mm, up to and including 100 mm, shall be square four-bolt type; and sizes over 100 mm shall be round.

#### 2.8.3.3 Steel Tubing

Steel tubing for refrigeration service shall be in accordance with ASTM A 334/A334M, Grade 1. Tubing with a nominal diameter of 10 mm or 15 mm shall have a wall thickness of 1.24 mm. Tubing with a nominal diameter of 20 mm through 50 mm shall have a wall thickness of 1.65 mm. Tubing with a nominal diameter of 65 mm through 100 mm shall have a wall thickness of 2.41 mm. Steel tubing shall be cold-rolled, electric-forged, welded-steel. One end of the tubing shall be provided with a socket. Steel tubing shall be cleaned, dehydrated, and capped.

#### 2.8.3.4 Steel Tubing Joints and Fittings

Joints and fittings shall be socket type provided by the steel tubing manufacturer.

#### 2.8.3.5 Copper Tubing

Copper tubing shall conform to ASTM B 280 annealed or hard drawn as required. Copper tubing shall be soft annealed where bending is required

and hard drawn where no bending is required. Soft annealed copper tubing shall not be used in sizes larger than 35 mm. Joints shall be brazed except that joints on lines 22 mm and smaller may be flared.

#### 2.8.3.6 Copper Tube Joints and Fittings

Copper tube joints and fittings shall be flare joint type with short-shank flare, or solder-joint pressure type. Joints and fittings for brazed joint shall be wrought-copper or forged-brass sweat fittings. Cast sweat-type joints and fittings shall not be allowed for brazed joints.

#### 2.8.4 Refrigerant Piping, Valves, and Accessories

Valves shall be pressure and temperature rates for contained refrigerant service and shall comply with ASME B31.5. Metals of constructions shall be ferrous or copper based. Atmosphere exposed valve stems shall be stainless steel or corrosion resistant metal plated carbon steel. Valve body connections shall not be used, except in pilot pressure or gauge lines where maintenance disassembly is required and welded flanges cannot be used. Valves shall be suitable for or fitted with extended copper ends for brazing in-place without disassembly. Ferrous body valves shall be fitted with factory fabricated and brazed copper transitions. To minimize system pressure drops, where practicable, globe valves shall be angle body type, and straight line valves shall be full port ball type. Control valve inlets shall be fitted with integral or adapted strainer or filter where recommended or required by the manufacturer. Valves shall be cleaned and sealed moisture-tight.

##### 2.8.4.1 Refrigerant-Stop Valves

Valves, in sizes through 15 mm, shall be handwheel operated, straight or angle, packless diaphragm globe type with back-seating stem, brazed ends, except where SAE flare or retained seal cap connections are required. In sizes over 15 mm, valves shall be globe or angle type, wrench operated with ground-finish stems, or ball valves, packed especially for refrigerant service, back seated, and provided with seal caps. Refrigerant isolation and shut-off valves shall have retained or captive spindles and facilities for tightening or replacement of the gland packing under line pressure as applicable. Stop valves shall have back-seating plated steel stem, bolted bonnet in sizes 25 mm OD and larger, integral or flanged transition brazed socket. Valves in sizes through 65 mm shall be end-entry body assembly, full-port, floating ball type, with equalizing orifice fitted chrome plated ball, seats and seals of tetrafluoroethylene, chrome plated or stainless steel stem, and seal cap. In sizes 100 mm IPS and larger, and in smaller sizes where carbon steel piping is used, valve bodies shall be tongue and groove flanged and complete with mating flange, gaskets and bolting for socket or butt-welded connection. Purge, charge and receiver valves shall be of manufacturer's standard configuration.

##### 2.8.4.2 Check Valves

Valve shall be designed for service application, spring-loaded type where required, with resilient seat and with flanged body in sizes 15 mm and larger. Valve shall provide positive shutoff at 10 kPa differential pressure.

#### 2.8.4.3 Liquid Solenoid Valves

Valves shall comply with ARI 760 and be suitable for continuous duty with applied voltages 15 percent under and 5 percent over nominal rated voltage at maximum and minimum encountered pressure and temperature service conditions. Valves shall be direct-acting or pilot-operating type, packless, except that packed stem, seal capped, manual lifting provisions shall be furnished. Solenoid coils shall be moisture-proof, UL approved, totally encapsulated or encapsulated and metal jacketed as required. Valves shall have safe working pressure of 2760 kPa and a maximum operating pressure differential of at least 1375 kPa at 85 percent rated voltage. Valves shall have an operating pressure differential suitable for the refrigerant used.

#### 2.8.4.4 Expansion Valves

Expansion valves shall conform to requirements of ARI 750. Valve shall be of the diaphragm and spring type with internal or external equalizers, and bulb and capillary tubing. Valve shall be provided with an external superheat adjustment along with a seal cap. Internal equalizers may be utilized where flowing refrigerant pressure drop between outlet of the valve and inlet to the evaporator coil is negligible and pressure drop across the evaporator is less than the pressure difference corresponding to 1 degrees C of saturated suction temperature at evaporator conditions. Bulb charge shall be determined by the manufacturer for the application and such that liquid will remain in the bulb at all operating conditions. Gas limited liquid charged valves and other valve devices for limiting evaporator pressure shall not be used without a distributor or discharge tube or effective means to prevent loss of control when bulb becomes warmer than valve body. Pilot-operated valves shall have a characterized plug to provide required modulating control. A de-energized solenoid valve may be used in the pilot line to close the main valve in lieu of a solenoid valve in the main liquid line. An isolatable pressure gauge shall be provided in the pilot line, at the main valve. Automatic pressure reducing or constant pressure regulating expansion valves may be used only where indicated or for constant evaporator loads.

#### 2.8.4.5 Safety Relief Valves

Valve shall be two-way type. Single type valves shall be used only where indicated. Valve shall bear the ASME code symbol. Valve capacity shall be certified by the National Board of Boiler and Pressure Vessel Inspectors. Valve shall be of an automatically reseating design after activation.

#### 2.8.4.6 Evaporator Pressure Regulators, Direct-Acting

Valve shall include a diaphragm/spring assembly, external pressure adjustment with seal cap, and pressure gauge port. Valve shall maintain a constant inlet pressure by balancing inlet pressure on diaphragm against an adjustable spring load. Pressure drop at system design load shall not exceed the pressure difference corresponding to a 1 degrees C change in saturated refrigerant temperature at evaporator operating suction temperature. Spring shall be selected for indicated maximum allowable suction pressure range.

#### 2.8.4.7 Refrigerant Access Valves

Refrigerant access valves and hose connections shall be in accordance with ARI ANSI/ARI 720.

#### 2.8.4.8 Filter Driers

Driers shall conform to ARI ANSI/ARI 710. Sizes 15 mm and larger shall be the full flow, replaceable core type. Sizes 15 mm and smaller shall be the sealed type. Cores shall be of suitable desiccant that will not plug, cake, dust, channel, or break down, and shall remove water, acid, and foreign material from the refrigerant. Filter driers shall be constructed so that none of the desiccant will pass into the refrigerant lines. Minimum bursting pressure shall be 10.3 MPa.

#### 2.8.4.9 Sight Glass and Liquid Level Indicator

- a. Assembly and Components: Assembly shall be pressure- and temperature-rated and constructed of materials suitable for the service. Glass shall be borosilicate type. Ferrous components subject to condensation shall be electro-galvanized.
- b. Gauge Glass: Gauge glass shall include top and bottom isolation valves fitted with automatic checks, and packing followers; red-line or green-line gauge glass; elastomer or polymer packing to suit the service; and gauge glass guard.
- c. Bull's-Eye and Inline Sight Glass Reflex Lens: Bull's-eye and inline sight glass reflex lens shall be provided for dead-end liquid service. For pipe line mounting, two plain lenses in one body suitable for backlighting viewing shall be provided.
- d. Moisture Indicator: Indicator shall be a self-reversible action, moisture reactive, color changing media. Indicator shall be furnished with full-color-printing tag containing color, moisture and temperature criteria. Unless otherwise indicated, the moisture indicator shall be an integral part of each corresponding sight glass.

#### 2.8.4.10 Vibration Dampers

Dampers shall be of the all-metallic bellows and woven-wire type.

#### 2.8.4.11 Flexible Pipe Connectors

Connector shall be pressure and temperature rated for the service in accordance with ASHRAE 15 and ASME B31.5. Connector shall be a composite of interior corrugated phosphor bronze or Type 300 Series stainless steel, as required for fluid service, with exterior reinforcement of bronze, stainless steel or monel wire braid. Assembly shall be constructed with a safety factor of not less than 4 at 150 degrees C. Unless otherwise indicated, the length of a flexible connector shall be as recommended by the manufacturer for the service intended.

#### 2.8.4.12 Strainers

Strainers used in refrigerant service shall have brass or cast iron body, Y- or angle-pattern, cleanable, not less than 60-mesh noncorroding screen of an area to provide net free area not less than ten times the pipe diameter with pressure rating compatible with the refrigerant service. Screens shall be stainless steel or monel and reinforced spring-loaded where necessary for bypass-proof construction.

#### 2.8.4.13 Brazing Materials

Brazing materials for refrigerant piping shall be in accordance with AWS A5.8, Classification BCuP-5.

### 2.9 FABRICATION

#### 2.9.1 Factory Coating

Unless otherwise specified, equipment and component items, when fabricated from ferrous metal, shall be factory finished with the manufacturer's standard finish, except that items located outside of buildings shall have weather resistant finishes that will withstand 500 hours exposure to the salt spray test specified in ASTM B 117 using a 5 percent sodium chloride solution. Immediately after completion of the test, the specimen shall show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 3 mm on either side of the scratch mark. Cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used shall be coated with a zinc-rich coating conforming to ASTM D 520, Type I.

#### 2.9.2 Field Painting

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory are specified in Section 09900 PAINTING, GENERAL.

##### 2.9.2.1 Color Coding

Color coding for piping identification is specified in Section 15190, IDENTIFICATION OF PIPING.

##### 2.9.2.2 Color Coding Scheme

A color coding scheme for locating hidden piping shall be in accordance with Section 15400 PLUMBING, GENERAL PURPOSE.

### 2.10 FACTORY TESTS

#### 2.10.1 Chiller Sound Test

All centrifugal chillers shall be sound tested at the factory prior to shipment to confirm the sound pressure level specified below. All tests and data shall be conducted and measured in strict accordance with ARI 575. The centrifugal chiller sound pressure level, in decibels (dB), with a reference pressure of 20 micropascals, shall not exceed 85 dB, A weighted, at full load. All ratings shall be in accordance with ARI 575. No reduction of entering condenser water temperature or raising of leaving chilled water

temperature shall be allowed. A minimum of 75 percent of the sound data points shall be taken along the length of the machine, and established as the minimum percentage of total possible points used to determine sound levels. In the event that the chiller does not meet the dBA sound pressure level, the manufacturer shall, at his expense, provide sufficient attenuation to the machine to meet the specified value. This attenuation shall be applied in such a manner that it does not hinder the operation or routine maintenance procedures of the chiller. The attenuation material, adhesives, coatings, and other accessories shall have surface burning characteristics as determined by ASTM E 84.

## 2.11 SUPPLEMENTAL COMPONENTS/SERVICES

### 2.11.1 Drain and Makeup Water Piping

Piping shall comply with the requirements of Section 15400 PLUMBING, GENERAL PURPOSE. Drains which connect to sanitary sewer system shall be connected by means of an indirect waste.

## 3 EXECUTION

### 3.1 INSTALLATION

All work shall be performed in accordance with the manufacturer's published diagrams, recommendations, and equipment warranty requirements. Where equipment is specified to conform to the requirements of ASME BPV VIII Div 1 and ASME BPV IX, the design, fabrication, and installation of the system shall conform to ASME BPV VIII Div 1 and ASME BPV IX.

#### 3.1.1 Refrigeration System

##### 3.1.1.1 Equipment

Necessary supports shall be provided for all equipment, appurtenances, and pipe as required, including frames or supports for compressors, pumps, cooling towers, condensers, liquid coolers, and similar items. Compressors shall be isolated from the building structure. mechanical vibration isolators are required as shown. Other floor-mounted equipment shall be set on not less than a 150 mm concrete pad doweled in place or as shown. Concrete foundations for floor mounted pumps shall have a mass equivalent to three times the weight of the components, pump, base plate, and motor to be supported. Isolators shall be selected and sized based on load-bearing requirements and the lowest frequency of vibration to be isolated and shall provide the min. static deflection shown. Lines connected to pumps mounted on pedestal blocks shall be provided with flexible connectors. Foundation drawings, bolt-setting information, and foundation bolts shall be furnished prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Concrete for foundations and concrete-structured or cased-cooling towers shall be as specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. Equipment shall be properly leveled, aligned, and secured in place in accordance with manufacturer's instructions.

##### 3.1.1.2 Refrigerant Charging

- a. Initial Charge: Upon completion of all the refrigerant pipe tests, the vacuum on the system shall be broken by adding the required

charge of dry refrigerant for which the system is designed, in accordance with the manufacturer's recommendations. Contractor shall provide the complete charge of refrigerant in accordance with manufacturer's recommendations. Upon satisfactory completion of the system performance tests, any refrigerant that has been lost from the system shall be replaced. After the system is fully operational, service valve seal caps and blanks over gauge points shall be installed and tightened.

- b. Refrigerant Leakage: If a refrigerant leak is discovered after the system has been charged, the leaking portion of the system shall immediately be isolated from the remainder of the system and the refrigerant shall be pumped into the system receiver or other suitable container. The refrigerant shall not be discharged into the atmosphere.
- c. Contractor's Responsibility: The Contractor shall, at all times during the installation and testing of the refrigeration system, take steps to prevent the release of refrigerants into the atmosphere. The steps shall include, but not be limited to, procedures which will minimize the release of refrigerants to the atmosphere and the use of refrigerant recovery devices to remove refrigerant from the system and store the refrigerant for reuse or reclaim. At no time shall more than 85 g of refrigerant be released to the atmosphere in any one occurrence. Any system leaks within the first year shall be repaired in accordance with the specified requirements including material, labor, and refrigerant if the leak is the result of defective equipment, material, or installation.

#### 3.1.1.3 Oil Charging

Except for factory sealed units, two complete charges of lubricating oil for each compressor crankcase shall be furnished. One charge shall be used during the performance testing period, and upon the satisfactory completion of the tests, the oil shall be drained and replaced with the second charge.

#### 3.1.1.4 Automatic Controls

Automatic controls for the central refrigeration system specified in paragraph REFRIGERATION SYSTEM shall be provided with the central refrigeration equipment. These controls shall operate automatically to balance the equipment capacity with the load on the air conditioning system, and shall be fully coordinated with and integrated into the temperature control system specified in Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM and 15950 HEATING, VENTILATING AND AIR CONDITIONING (HVAC) CONTROL SYSTEMS.

### 3.1.2 General Piping Installation

#### 3.1.2.1 Brazed Joints

Before brazing copper joints, both the outside of the tube and the inside of the fitting shall be cleaned with a wire fitting brush until the entire joint surface is bright and clean. Brazing flux shall not be used. Surplus brazing material shall be removed at all joints. Steel tubing joints shall be made in accordance with the manufacturer's recommendations. Joints in



steel tubing shall be painted with the same material as the baked-on coating within 8 hours after joints are made. Tubing shall be protected against oxidation during brazing by continuous purging of the inside of the piping using nitrogen. All piping shall be supported prior to brazing and shall not be sprung or forced.

#### 3.1.2.2 Threaded Joints

Threaded joints shall be made with tapered threads and made tight with PTFE tape complying with ASTM D 3308 or equivalent thread-joint compound applied to the male threads only. Not more than three threads shall show after the joint is made.

#### 3.1.2.3 Welded Joints

Welding shall be in accordance with qualified procedures using qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPV IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. Contracting Officer shall be notified 24 hours in advance of welding tests and the tests shall be performed at the work site if practical. A permanent mark shall be applied near each weld to identify the welder who made that weld. Welded joints in steel refrigerant piping shall be fusion-welded. Changes in direction of piping shall be made with welded fittings only; mitering or notching pipe or other similar construction to form elbows or tees will not be permitted. Branch connections shall be made with welding tees or forged welding branch outlets. Steel pipe shall be thoroughly cleaned of all scale and foreign matter before the piping is assembled. During welding the pipe and fittings shall be filled with an inert gas, such as nitrogen, to prevent the formation of scale. Beveling, alignment, heat treatment, and inspection of weld shall conform to ASME B31.1. Weld defects shall be removed and rewelded at no additional cost to the Government. Electrodes shall be stored and dried in accordance with AWS D1.1 or as recommended by the manufacturer. Electrodes that have been wetted or that have lost any of their coating shall not be used.

#### 3.1.2.4 Flanged Joints

Flanged joints shall be faced true, provided with gaskets suitable for use with refrigerants and made square and tight. When steel refrigerant piping is used, union or flange joints shall be provided in each line immediately preceding the connection to each piece of equipment requiring maintenance, such as compressors, coils, chillers, control valves, and other similar items.

#### 3.1.2.5 Flared Connections

When flared connections are used, a suitable lubricant shall be used between the back of the flare and the nut in order to avoid tearing the flare while tightening the nut.

#### 3.1.2.6 Thermometers

Thermometers shall be located specifically on, but not limited to the following: the sensing element of each automatic temperature control device where a thermometer is not an integral part thereof].

## 3.1.2.7 Supports

- a. General: All refrigerant pipe supports shall be in accordance with ASME B31.5. Hangers used to support piping 50 mm and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Pipe guides and anchors shall be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Piping subjected to vertical movement, when operating temperatures exceed ambient temperatures, shall be supported by variable spring hangers and supports or by constant support hangers.
- b. Seismic Requirements: All piping and attached valves shall be supported and braced to resist seismic loads as specified under Section 13080 SEISMIC PROTECTION FOR MECHANICAL, ELECTRICAL EQUIPMENT as shown on the drawings. Structural steel required for reinforcement to properly support piping, headers, and equipment but not shown shall be provided under this section. Material used for support shall be as specified under Section 05120 STRUCTURAL STEEL.
- c. Structural Attachments: Structural steel brackets required to support piping, headers, and equipment, but not shown, shall be provided under this section. Material and installation shall be as specified under Section 05120 STRUCTURAL STEEL.

## 3.1.2.8 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69, except as modified herein. Pipe hanger types 5, 12, and 26 shall not be used.

- a. Hangers: Type 3 shall not be used on insulated piping.
- b. Inserts: Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustments may be used if they otherwise meet the requirements for Type 18 inserts.
- c. C-Clamps: Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.
- d. Angle Attachments: Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.
- e. Hangers: Type 24 may be used only on trapeze hanger systems or on fabricated frames.
- f. Saddles and Shields: Where Type 39 saddle or Type 40 shield are permitted for a particular pipe attachment application, the Type 39 saddle, connected to the pipe, shall be used on all pipe 100 mm and larger when the temperature of the medium is 16 degrees C or

higher. Type 40 shields shall be used on all piping less than 100 mm and all piping 100 mm and larger carrying medium less than 16 degrees C. A high density insulation insert of cellular glass shall be used under the Type 40 shield for piping 50 mm and larger.

- g. Horizontal Pipe Supports: Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 300 mm from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 1.5 m apart at valves.
- h. Vertical Pipe Supports: Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 4.5 m, not more than 2.4 m from end of risers, and at vent terminations.
- i. Pipe Guides: Type 35 guides using, steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.
- j. Steel Slides: Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 100 mm and larger, a Type 39 saddle shall be used. On piping under 100 mm, a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.
- k. High Temperature Guides with Cradles: Where there are high system temperatures and welding to piping is not desirable, then the Type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 100 mm, or by an amount adequate for the insulation, whichever is greater.
- l. Multiple Pipe Runs: In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run.

#### 3.1.2.9 Pipe Sleeves

Sleeves shall not be installed in structural members except where indicated or approved. Rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective wall, floor, or roof, and shall be cut flush with each surface. Pipes passing through concrete or masonry wall or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Unless otherwise indicated, sleeves shall be of such size as to provide a minimum of 6 mm all-around clearance between bare pipe and sleeves or between jacketed-insulation and sleeves. Sleeves in bearing walls, waterproofing membrane floors, and wet areas shall be steel pipe or cast iron pipe. Sleeves in non-bearing walls, floors, or ceilings may be steel pipe, cast iron pipe, galvanized sheet metal with lock-type longitudinal seam and of the metal thickness indicated, or moisture resistant fiber or plastic. Except in pipe chases or interior

walls, the annular space between pipe and sleeve or between jacket over-insulation and sleeve shall be sealed as indicated and specified in Section 07900 JOINT SEALING. Pipes passing through wall waterproofing membrane shall be sleeved as specified above, and a waterproofing clamping flange shall be installed.

- a. Roof and Floor Penetrations: Pipes passing through roof or floor waterproofing membrane shall be installed through a 5.17 kg/sq. m. copper sleeve, or a 0.81 mm thick aluminum sleeve, each within an integral skirt or flange. Flashing sleeve shall be suitably formed, and skirt or flange shall extend not less than 200 mm from the pipe and shall be set over the roof or floor membrane in a troweled coating of bituminous cement. The flashing sleeve shall extend up the pipe a minimum of 50 mm above highest floor level of the roof or a minimum of 250 mm above the roof, whichever is greater, or 250 mm above the floor. The annular space between the flashing sleeve and the bare pipe or between the flashing sleeve and the metal-jacket-covered insulation shall be sealed as indicated. Pipes up to and including 250 mm in diameter passing through roof or floor waterproofing membrane may be installed through a cast iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Waterproofing membrane shall be clamped into place and sealant shall be placed in the caulking recess. In lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve or conduit and sleeve, a modular mechanical type sealing assembly may be installed. Seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal between the pipe/conduit seal between the pipe/conduit and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe/conduit and sleeve involved. The Contractor electing to use the modular mechanical type seals shall provide sleeves of the proper diameters.
- b. Fire-Rated Walls and Partitions: Penetration of fire-rated walls and partitions shall be sealed as specified in Section 07270 FIRESTOPPING.

#### 3.1.2.10 Escutcheons

Finished surfaces where exposed piping, bare or insulated, pass through floors, walls, or ceilings, except in boiler, utility, or equipment rooms, shall be provided with escutcheons. Where sleeves project slightly from floors, special deep-type escutcheons shall be used. Escutcheon shall be secured to pipe or pipe covering.

#### 3.1.2.11 Access Panels

Access panels shall be provided for all concealed valves, vents, controls, and items requiring inspection or maintenance. Access panels shall be of

sufficient size and located so that the concealed items may be serviced and maintained or completely removed and replaced. Access panels shall be as specified in Section 05500 MISCELLANEOUS METALS.

### 3.1.3 Water Piping

Pipe and fitting installation shall conform to the requirements of ASME B31.1. Pipe shall be cut accurately to measurements established at the jobsite, and worked into place without springing or forcing, completely clearing all windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted without written approval. Pipe or tubing shall be cut square, shall have burrs removed by reaming, and shall permit free expansion and contraction without causing damage to the building structure, pipe, joints, or hangers.

#### 3.1.3.1 Directional Changes

Changes in direction shall be made with fittings, except that bending of pipe 100 mm and smaller will be permitted, provided a pipe bender is used and wide weep bends are formed. The centerline radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted.

#### 3.1.3.2 Functional Requirements

Horizontal supply mains shall pitch down in the direction of flow as indicated. The grade shall not be less than 2 mm in 1 m. Reducing fittings shall be used for changes in pipe sizes. Open ends of pipelines and equipment shall be capped or plugged during installation to keep dirt or other foreign materials out of the system. Pipe not otherwise specified shall be uncoated. Connections to appliances shall be made with malleable iron unions for steel pipe 65 mm or less in diameter, and with flanges for pipe 80 mm and above in diameter. Connections between ferrous and copper piping shall be electrically isolated from each other with dielectric unions or flanges. All piping located in air plenums shall conform to NFPA 90A requirements. Pipe and fittings installed in inaccessible conduits or trenches under concrete floor slabs shall be welded.

#### 3.1.3.3 Valves

Isolation gate or ball valves shall be installed on each side of each piece of equipment, at the midpoint of all looped mains, and at any other points indicated or required for draining, isolating, or sectionalizing purpose. Isolation valves may be omitted where balancing cocks are installed to provide both balancing and isolation functions. Each valve except check valves shall be identified. Valves in horizontal lines shall be installed with stems horizontal or above.

#### 3.1.3.4 Air Vents

Air vents shall be provided at all high points, on all water coils, and where indicated to ensure adequate venting of the piping system.

#### 3.1.3.5 Drains

Drains shall be provided at all low points and where indicated to ensure complete drainage of the piping. Drains shall be accessible, and shall consist of nipples and caps or plugged tees unless otherwise indicated.

#### 3.1.3.6 Flexible Pipe Connectors

Preinsulated flexible pipe connectors shall be attached to other components in strict accordance with the latest printed instructions of the manufacturer to ensure a vapor tight joint. Hangers, when required to suspend the connectors, shall be of the type recommended by the flexible pipe connector manufacturer and shall be provided at the intervals recommended.

#### 3.1.3.7 Flanges and Unions

Except where copper tubing is used, union or flanged joints shall be provided in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control valves, and other similar items.

#### 3.1.3.8 Grooved Mechanical Joints

Grooves shall be prepared in accordance with the coupling manufacturer's instructions. Pipe and groove dimensions shall comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field shall be measured using a "go/no-go" gauge, vernier or dial caliper, or narrow-land micrometer. Groove width and dimension of groove from end of pipe shall be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances.

#### 3.1.4 Refrigeration Piping

Unless otherwise specified, pipe and fittings installation shall conform to requirements of ASME B31.5. Pipe shall be cut accurately to measurement established at the jobsite and worked into place without springing or forcing. Cutting or otherwise weakening of the building structure to facilitate piping installation will not be permitted without written approval. Pipes shall be cut square, shall have burrs removed by reaming, and shall be installed in a manner to permit free expansion and contraction without damage to joints or hangers. Filings, dust, or dirt shall be wiped from interior of pipe before connections are made.

##### 3.1.4.1 Directional Changes

Changes in direction shall be made with fittings, except that bending of pipe 100 mm and smaller will be permitted, provided a pipe bender is used and wide-sweep bends are formed. The centerline radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, or other malformations will not be accepted.

##### 3.1.4.2 Functional Requirements

All piping shall be installed 4 mm per m of pipe in the direction of flow to ensure adequate oil drainage. Open ends of refrigerant lines or equipment shall be properly capped or plugged during installation to keep moisture,

dirt, or other foreign material out of the system. Piping shall remain capped until installation. Equipment piping shall be in accordance with the equipment manufacturer's recommendations and the contract drawings.

#### 3.1.4.3 Valves

- a. Stop valves shall be installed on each side of each piece of equipment such as compressors condensers, evaporators, receivers, and other similar items in multiple-unit installation, to provide partial system isolation as required for maintenance or repair. Angle and globe valves shall be installed with stems horizontal unless otherwise indicated. Ball valves shall be installed with stems positioned to facilitate operation and maintenance. All valves except check valves shall be identified with a brass or aluminum tag not less than 35 mm in diameter, correctly stamped to explain the valve function, and with a number for identification. Tags shall be secured to the valve with No. 12 AWG copper wire.
- b. Expansion valves shall be installed with the thermostatic expansion valve bulb located on top of the suction line when the suction line is less than 54 mm in diameter and at the 4 o'clock or 8 o'clock position on lines larger than 54 mm. The bulb shall be securely fastened with two clamps. The bulb shall be insulated. The bulb shall installed in a horizontal portion of the suction line, if possible, with the pigtail on the bottom. If the bulb must be installed in a vertical line, the bulb tubing shall be facing up.

#### 3.1.4.4 Vibration Dampers

Vibration damper shall be provided in the suction and discharge lines on spring mounted compressors. Vibration dampers shall be installed parallel with the shaft of the compressor and shall be anchored firmly at the upstream end on the suction line and the downstream end in the discharge line.

#### 3.1.4.5 Strainers

Strainers shall be provided immediately ahead of all solenoid valves and expansion devices. Strainers may be an integral part of the expansion valve.

#### 3.1.4.6 Filter Dryer

A liquid line filter dryer shall be provided on each refrigerant circuit located such that all liquid refrigerant passes through a filter dryer. The filter dryer shall be sized in accordance with the manufacturer's recommendations for the system in which it is installed. The filter dryer shall be installed such that the filter dryer can be isolated from the system, the isolated portion of the system evacuated, and the filter dryer replaced. Filter dryers shall be installed in the horizontal position except replaceable core filter dryers may be installed in the vertical position with the access flange on the bottom.

#### 3.1.4.7 Sight Glass

A moisture indicating sight glass shall be installed in all refrigerant circuits down stream of all filter dryers.

#### 3.1.4.8 Discharge Line Oil Separator

Discharge line oil separator shall be provided in the discharge line from each compressor. Oil return line shall be connected to the compressor as recommended by the compressor manufacturer.

#### 3.1.4.9 Accumulator

Accumulators shall be provided in the suction line to each compressor.

#### 3.1.5 Mechanical Room Ventilation

Mechanical rooms containing a central refrigerated air-conditioning system shall be ventilated to the outdoors. The ventilation system shall be in accordance with Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

#### 3.1.6 Field Applied Insulation

Field applied insulation other than that specified for water boxes and headers shall be as specified in Section 15250 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

#### 3.1.7 Factory Applied Insulation

##### 3.1.7.1 Refrigerant Suction Lines

Refrigerant suction lines between the cooler and each compressor and cold gas inlet connections to gas cooled motors. Refrigerant pumps and exposed chilled water lines on absorption chillers shall be insulated with not less than 19 mm thick unicellular plastic foam.

##### 3.1.7.2 Liquid Coolers

Liquid coolers including chilled water headers or boxes, which may have factory or field applied insulation, shall be insulated with unicellular plastic foam. Insulation shall be not less than 19 mm thick or have a maximum thermal conductivity of  $1.59 \text{ W}/((\text{sq. m})(\text{degree K}))$ . In lieu of the above insulation, a 50 mm thickness of urethane foam may be used. Urethane foam shall be completely covered and sealed with a sheet metal jacket not lighter than 1.0 mm. Insulation on heads of coolers shall be constructed to provide easy removal and replacement of heads without damage to the insulation.

#### 3.2 TESTS

##### 3.2.1 Field Tests

Tests shall be conducted in the presence of the Contracting Officer. Water and electricity required for the tests will be furnished by the Government. Any material, equipment, instruments, and personnel required for the test shall be provided by the Contractor. The services of a qualified technician shall be provided as required to perform all tests and procedures indicated herein. Field tests shall be coordinated with Section 15990 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.



### 3.2.1.1 Water Pipe Testing

After cleaning, water piping shall be hydrostatically tested at a pressure equal to 150 percent of the total system operating pressure for period of time sufficient to inspect every joint in the system and in no case less than 2 hours. Leaks shall be repaired and piping retested until test is successful. No loss of pressure shall be allowed. Leaks shall be repaired by rewelding or replacing pipe or fittings. Caulking of joints will not be permitted. Concealed and insulated piping shall be tested in place before concealing.

### 3.2.1.2 Refrigerant Pipe Testing

- a. Refrigerant Leakage Test: After all components of the refrigerant system have been installed and the piping connected, the system shall be subjected to a refrigerant leakage test. The refrigerant leakage test shall be done with dry nitrogen before any refrigerant pipe is insulated or covered. High and low side of the refrigerant system shall be tested for the minimum refrigerant leakage test pressure specified in ASHRAE 15, for the refrigerant employed in the system. System shall be proved tight and free of leaks by allowing the refrigerant leakage test pressure to remain on the system for 24 hours with no drop in pressure. The initial test pressure and surrounding air temperature will be recorded. After the 24 hour hold period, the final system pressure and surrounding air temperature will be recorded. A correction of 3.7 kPa shall be allowed for each degree C change in the initial and final temperature of the surrounding air, plus for an increase and minus for a decrease. The system shall have passed the refrigerant leakage test if the corrected final system pressure is equal to the initial system test pressure. If the pressures are not equal, the leaks shall be located and repaired.
- b. Refrigerant Leaks: To repair leaks, the joint shall be taken apart, thoroughly cleaned, and remade as a new joint. Joints repaired by caulking or remelting and adding more brazing material will not be acceptable. After leak repairs have been made, the refrigerant leakage test shall be conducted again.
- c. Evacuation Test: After the foregoing tests have been satisfactorily completed and the pressure relieved, entire system shall be evacuated to an absolute pressure of 300 microns. During evacuation of the system, the ambient temperature shall be higher than 2 degrees C. Vacuum line shall be closed, and the system shall stand for 1 hour. After this period, the absolute pressure shall not exceed 500 microns. If the pressure rises over 500 microns, the system shall continue to be evacuated until the system reaches 300 microns and can stand for 1 hour with the vacuum line closed without the absolute pressure rising over 500 microns. During evacuation, pressures shall be recorded by a thermocouple type, electronic type, or a calibrated-micron type gauge.

### 3.2.2 System Performance Tests

After the foregoing tests have been completed and before each refrigeration system is accepted, tests to demonstrate the general operating characteristics of all equipment shall be conducted by a registered

professional engineer or an approved manufacturer's startup representative experienced in system startup and testing, at such times as directed. Tests shall cover a period of not less than 5 days for each system and shall demonstrate that the entire system is functioning in accordance with the drawings and specifications. Corrections and adjustments shall be made as necessary and tests shall be re-conducted to demonstrate that the entire system is functioning as specified.

### 3.3 INSPECTIONS

At the conclusion of the one year period, the cooling tower and condenser shall be inspected for problems due to corrosion, scale, and biological growth. If the cooling tower and condenser are found not to conform to the manufacturers recommended conditions, and the water treatment company recommendations have been followed; the water treatment company shall provide all chemicals and labor for cleaning or repairing the equipment as required by the manufacturer's recommendations.

### 3.4 MANUFACTURER'S FIELD SERVICE

The services of a factory-trained representative shall be provided for 2 days. The representative shall advise on the following:

a. Hermetic machines:

- (1) Testing hermetic water-chilling unit under pressure for refrigerant leaks; evacuation and dehydration of machine to an absolute pressure of not over 300 microns.
- (2) Charging the machine with refrigerant.
- (3) Starting the machine.

b. Open Machines:

- (1) Erection, alignment, testing, and dehydrating.
- (2) Charging the machine with refrigerant.
- (3) Starting the machine.

c. Absorption Units:

- (1) Testing and evacuation.
- (2) Charging the machine with refrigerant.
- (3) Starting the machine.

### 3.5 CLEANING AND ADJUSTING

#### 3.5.1 Piping

Pipes shall be cleaned free of scale and thoroughly flushed of all foreign matter. A temporary bypass shall be provided for all water coils to prevent flushing water from passing through coils. Strainers and valves shall be thoroughly cleaned. Prior to testing and balancing, air shall be removed

from all water systems by operating the air vents. Temporary measures, such as piping the overflow from vents to a collecting vessel shall be taken to avoid water damage during the venting process. Air vents shall be plugged or capped after the system has been vented.

### 3.5.2 Equipment

Equipment shall be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. Temporary filters shall be provided for all fans that are operated during construction, and new filters shall be installed after all construction dirt has been removed from the building. System shall be maintained in this clean condition until final acceptance. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions.

### 3.6 DEMONSTRATIONS

Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total 16 hours of normal working time and start after the system is functionally completed but prior to final acceptance tests. The field instructions shall cover all of the items contained in the Operation and Maintenance Manuals as well as demonstrations of routine maintenance operations.

## SECTION 15895

## AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ARI 350	(1986) Sound Rating of Non-Ducted Indoor Air-Conditioning Equipment
ARI 410	(1991) Forced-Circulation Air-Cooling and Air-Heating Coils
ARI 430	(1989) Central-Station Air-Handling Units
ARI 440	(1993) Room Fan-Coil and Unit Ventilator
ARI Guideline D	(1987) Application and Installation of Central Station Air-Handling Units

## AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)

AMCA 210	(1985) Laboratory Methods of Testing Fans for Rating
AMCA 300	(1996) Reverberant Room Method for Sound Testing of Fans

## AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABEMA)

ABEMA 9	(1990) Load Ratings and Fatigue Life for Ball Bearings
ABEMA 11	(1990) Load Ratings and Fatigue Life for Roller Bearings

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 47	(1990) Ferritic Malleable Iron Castings
ASTM A 53	(1993a) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 106	(1994) Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A 123	(1989a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A 167	(1993) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 181	(1995b) Forgings, Carbon Steel, for General-Purpose Piping
ASTM A 183	(1983; R 1990) Carbon Steel Track Bolts and Nuts
ASTM A 193	(1996) Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A 234	(1996) Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM A 536	(1984; R 1993) Ductile Iron Castings
ASTM A 733	(1993) Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM A 924	(1994) General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B 62	(1993) Composition Bronze or Ounce Metal Castings
ASTM B 75	(1993) Seamless Copper Tube
ASTM B 88	(1993a) Seamless Copper Water Tube
ASTM B 117	(1994) Operating Salt Spray (Fog) Testing Apparatus
ASTM C 916	(1985; R 1990) Adhesives for Duct Thermal Insulation
ASTM C 1071	(1991) Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material)
ASTM D 520	(1984; R 1989) Zinc Dust Pigment
ASTM D 1384	(1994) Corrosion Test for Engine Coolants in Glassware
ASTM D 1654	(1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D 2000	(1990 R 1994) Rubber Products in Automotive Applications
ASTM D 3359	(1995) Measuring Adhesion by Tape Test
ASTM E 84	(1994) Surface Burning Characteristics of Building Materials

ASTM E 437 (1992) Industrial Wire Cloth and Screens  
(Square Opening Series)

ASTM F 1199 (1988; R 1993) Cast (All Temperature and  
Pressures) and Welded Pipe Line Strainers  
(150 psig and 150 degrees F Maximum)

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING  
ENGINEERS (ASHRAE)

ASHRAE 52.1 (1992) Gravimetric and Dust-Spot Procedures  
for Testing Air-Cleaning Devices Used in  
General Ventilation for Removing Particulate  
Matter

ASHRAE 68 (1986) Laboratory Method of Testing In-Duct  
Sound Power Measurement Procedures for Fans

ASHRAE 70 (1991) Method of Testing Rating the  
Performance of Air Outlets and Inlets

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1 (1983; R 1992) Pipe Threads, General Purpose  
(Inch)

ASME B16.3 (1992) Malleable Iron Threaded Fittings

ASME B16.5 (1988; Errata Oct 88; B16.5a) Pipe Flanges  
and Flanged Fittings

ASME B16.9 (1993) Factory-Made Wrought Steel Buttwelding  
Fittings

ASME B16.11 (1991) Forged Fittings, Socket-Welding and  
Threaded

ASME B16.18 (1984; R 1994) Cast Copper Alloy Solder Joint  
Pressure Fittings

ASME B16.21 (1992) Nonmetallic Flat Gaskets for Pipe  
Flanges

ASME B16.22 (1989) Wrought Copper and Copper Alloy Solder  
Joint Pressure Fittings

ASME B16.26 (1988) Cast Copper Alloy Fittings for Flared  
Copper Tubes

ASME B16.39 (1986; R 1994) Malleable Iron Threaded Pipe  
Unions Classes 150, 250, and 300

ASME B31.1 (1995) Power Piping

ASME B40.1 (1991) Gauges - Pressure Indicating Dial Type  
- Elastic Element

ASME BPV IX (1995; Addenda Dec 1995) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C606 (1987) Grooved and Shouldered Joints

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1 (1994) Structural Welding Code - Steel

COMMERCIAL ITEM DESCRIPTIONS (CID)

CID A-A-1419 (Rev D) Filter Element, Air Conditioning (Viscous-Impingement and Dry Types, Replaceable)

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25 (1993) Standard Marking System for Valves, Fittings, Flanges and Unions

MSS SP-58 (1993) Pipe Hangers and Supports - Materials, Design and Manufacture

MSS SP-69 (1991) Pipe Hangers and Supports - Selection and Application

MSS SP-70 (1990) Cast Iron Gate Valves, Flanged and Threaded Ends

MSS SP-71 (1990) Cast Iron Swing Check Valves, Flanged and Threaded Ends

MSS SP-72 (1992) Ball Valves with Flanged or Butt-Welding Ends for General Service

MSS SP-80 (1987) Bronze Gate, Globe, Angle and Check Valves

MSS SP-85 (1994) Cast Iron Globe & Angle Valves, Flanged and Threaded Ends

MSS SP-110 (1991) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1 (1993; Rev 1; Rev 2) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A (1993) Installation of Air Conditioning and Ventilating Systems

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION  
(SMACNA)

SMACNA-05	(1992) Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems
SMACNA-06	(1995) HVAC Duct Construction Standards - Metal and Flexible
SMACNA-10	(1985) HVAC Air Duct Leakage Test Manual

## UNDERWRITERS LABORATORIES (UL)

UL-01	(1996; Supple) Building Materials Directory
UL-05	(1996; Supple) Fire Resistance Directory (3 Vol.)
UL 181	(1996; Rev Oct 1996) Factory-Made Air Ducts and Air Connectors
UL 214	(1993) Tests for Flame-Propagation of Fabrics and Films
UL 555	(1995) Fire Dampers
UL 586	(1996) High-Efficiency, Particulate, Air Filter Units
UL 723	(1993; Rev Apr 1994) Test for Surface Burning Characteristics of Building Materials
UL 900	(1994) Test Performance of Air Filter Units
UL 1995	(1995) Heating and Cooling Equipment

## 1.2 COORDINATION OF TRADES

Ductwork, piping offsets, fittings, and accessories shall be furnished as required to provide a complete installation and to eliminate interference with other construction.

## 1.3 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

## 1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:



## SD-01 Data

Components and Equipment Data; GA.

Manufacturer's catalog data shall be included with the detail drawings for the following items. The data shall be highlighted to show model, size, options, etc., that are intended for consideration. Data shall be adequate to demonstrate compliance with contract requirements for the following:

- a. Piping Components
- b. Ductwork Components
- c. Air Systems Equipment
- d. Air Handling Units
- e. Terminal Units

## SD-04 Drawings

Air Supply, Distribution, Ventilation, and Exhaust Equipment; GA.

Drawings shall consist of equipment layout including assembly and installation details and electrical connection diagrams; ductwork layout showing the location of all supports and hangers, typical hanger details, gauge reinforcement, reinforcement spacing rigidity classification, and static pressure and seal classifications; and piping layout showing the location of all guides and anchors, the load imposed on each support or anchor, and typical support details. Drawings shall include any information required to demonstrate that the system has been coordinated and will properly function as a unit and shall show equipment relationship to other parts of the work, including clearances required for operation and maintenance.

## SD-06 Instructions

Test Procedures; GA.

Proposed test procedures for piping hydrostatic test, ductwork leak test, and performance tests of systems, at least 2 weeks prior to the start of related testing.

Welding Procedures; FIO.

A copy of qualified welding procedures, at least 2 weeks prior to the start of welding operations.

System Diagrams; GA.

Proposed diagrams, at least 2 weeks prior to start of related testing. System diagrams that show the layout of equipment, piping, and ductwork, and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system shall be framed under glass or laminated plastic. After approval, these items shall be posted where directed.

## SD-07 Schedules

Test Schedules; GA.

Proposed test schedules for hydrostatic test of piping, ductwork leak test, and performance tests, at least 2 weeks prior to the start of related testing.

Field Training Schedule; GA.

Proposed schedule for field training, at least 2 weeks prior to the start of related training.

## SD-08 Statements

Similar Services; FIO.

Statement demonstrating successful completion of similar services on at least 5 projects of similar size and scope, at least 2 weeks prior to submittal of other items required by this section.

Welding Qualification; FIO.

A list of names and identification symbols of qualified welders and welding operators, at least 2 weeks prior to the start of welding operations.

## SD-09 Reports

Test Reports; GA.

Test reports for the piping hydrostatic test, ductwork leak test, and performance tests in booklet form, upon completion of testing. Reports shall document phases of tests performed including initial test summary, repairs/adjustments made, and final test results.

## SD-13 Certificates

Bolts; FIO.

Written certification from the bolt manufacturer that the bolts furnished comply with the requirements of this specification. The certification shall include illustrations of product markings, and the number of each type of bolt to be furnished.

## SD-19 Operation and Maintenance Manuals

Air Supply, Distribution, Ventilation, and Exhaust Manuals; GA.

Six manuals listing step-by-step procedures required for system startup, operation, shutdown, and routine maintenance, at least 2 weeks prior to field training. The manuals shall include the manufacturer's name, model number, parts list, list of parts and tools that should be kept in stock by the owner for routine maintenance including the name of a local supplier, simplified wiring and controls diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. Each service organization submitted shall be

capable of providing 4 hour onsite response to a service call on an emergency basis.

## 2 PRODUCTS

### 2.1 STANDARD PRODUCTS

Components and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of products that are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years before bid opening. The 2-year experience shall include applications of components and equipment under similar circumstances and of similar size. The 2 years must be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. The equipment items shall be supported by a service organization.

### 2.2 ASBESTOS PROHIBITION

Asbestos and asbestos-containing products shall not be used.

### 2.3 NAMEPLATES

Equipment shall have a nameplate that identifies the manufacturer's name, address, type or style, model or serial number, and catalog number.

### 2.4 EQUIPMENT GUARDS AND ACCESS

Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact shall be fully enclosed or guarded according to OSHA requirements. High temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard shall be properly guarded or covered with insulation of a type specified.

### 2.5 PIPING COMPONENTS

#### 2.5.1 Steel Pipe

Steel pipe shall conform to ASTM A 53, Schedule 40, Grade A or B, Type E or S.

#### 2.5.2 Joints and Fittings For Steel Pipe

Joints shall be welded, flanged, threaded, or grooved as indicated. If not otherwise indicated, piping 25 mm and smaller shall be threaded; piping larger than 25 mm and smaller than 80 mm shall be either threaded, grooved, or welded; and piping 80 mm and larger shall be grooved, welded, or flanged. Rigid grooved mechanical joints and fittings may only be used in serviceable aboveground locations where the temperature of the circulating medium does not exceed 110 degrees C. Flexible grooved joints shall be used only as a flexible connector with grooved pipe system. Unless otherwise specified, grooved piping components shall meet the corresponding criteria specified

for the similar welded, flanged, or threaded component specified herein. The manufacturer of each fitting shall be permanently identified on the body of the fitting according to MSS SP-25.

#### 2.5.2.1 Welded Joints and Fittings

Welded fittings shall conform to ASTM A 234, and shall be identified with the appropriate grade and marking symbol. Butt-welded fittings shall conform to ASME B16.9. Socket-welded fittings shall conform to ASME B16.11.

#### 2.5.2.2 Flanged Joints and Fittings

Flanges shall conform to ASTM A 181 and ASME B16.5, Class 150. Gaskets shall be nonasbestos compressed material according to ASME B16.21, 2.0 mm thickness, full face or self-centering flat ring type. The gaskets shall contain aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR). Bolts, nuts, and bolt patterns shall conform to ASME B16.5. Bolts shall be high or intermediate strength material conforming to ASTM A 193.

#### 2.5.2.3 Threaded Joints and Fittings

Threads shall conform to ASME B1.20.1. Unions shall conform to ASME B16.39, Class 150. Nipples shall conform to ASTM A 733. Malleable iron fittings shall conform to ASME B16.3, type as required to match piping.

#### 2.5.2.4 Dielectric Unions and Flanges

Dielectric unions shall have the tensile strength and dimensional requirements specified. Unions shall have metal connections on both ends threaded to match adjacent piping. Metal parts of dielectric unions shall be separated with a nylon insulator to prevent current flow between dissimilar metals. Unions shall be suitable for the required operating pressures and temperatures. Dielectric flanges shall provide the same pressure ratings as standard flanges and provide complete electrical isolation.

#### 2.5.2.5 Grooved Mechanical Joints and Fittings

Joints and fittings shall be designed for not less than 862 kPa (125 psig) service and shall be the product of the same manufacturer. Fitting and coupling houses shall be malleable iron conforming to ASTM A 47, Grade 32510; ductile iron conforming to ASTM A 536, Grade 65-45-12; or steel conforming to ASTM A 106, Grade B or ASTM A 53. Gaskets shall be molded synthetic rubber with central cavity, pressure responsive configuration and shall conform to ASTM D 2000 Grade No. 2CA615A15B44F17Z for circulating medium up to 110 degrees C or Grade No. M3BA610A15B44Z for circulating medium up to 93 degrees C. Grooved joints shall conform to AWWA C606. Coupling nuts and bolts shall be steel and shall conform to ASTM A 183.

#### 2.5.3 Copper Tube

Copper tube shall conform to ASTM B 88, Type K or L.

#### 2.5.4 Joints and Fittings For Copper Tube

Wrought copper and bronze solder-joint pressure fittings shall conform to ASME B16.22 and ASTM B 75. Cast copper alloy solder-joint pressure fittings shall conform to ASME B16.18. Cast copper alloy fittings for flared copper tube shall conform to ASME B16.26 and ASTM B 62. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment. Extracted brazed tee joints produced with an acceptable tool and installed as recommended by the manufacturer may be used.

#### 2.5.5 Valves

Valves shall be Class 125 and shall be suitable for the intended application. Valves shall meet the material, fabrication and operating requirements of ASME B31.1. Chain operators shall be provided for valves located 3 meters or higher above the floor. Valves in sizes larger than 25 mm and used on steel pipe systems, may be provided with rigid grooved mechanical joint ends. Such grooved end valves shall be subject to the same requirements as rigid grooved mechanical joints and fittings and, shall be provided by the same manufacturer as the grooved pipe joint and fitting system.

##### 2.5.5.1 Gate Valves

Gate valves 65 mm and smaller shall conform to MSS SP-80 and shall be bronze with rising stem and threaded, solder, or flanged ends. Gate valves 80 mm and larger shall conform to MSS SP-70 and shall be cast iron with bronze trim, outside screw and yoke, and flanged or threaded ends.

##### 2.5.5.2 Globe Valves

Globe valves 65 mm and smaller shall conform to MSS SP-80, bronze, threaded, soldered, or flanged ends. Globe valves 80 mm and larger shall conform to MSS SP-85 and shall be cast iron with bronze trim and flanged, or threaded ends.

##### 2.5.5.3 Check Valves

Check valves 65 mm and smaller shall conform to MSS SP-80 and shall be bronze with threaded, soldered, or flanged ends. Check valves 80 mm and larger shall conform to MSS SP-71 and shall be cast iron with bronze trim and flanged or threaded ends.

##### 2.5.5.4 Angle Valves

Angle valves 65 mm and smaller shall conform to MSS SP-80 and shall be bronze with threaded, soldered, or flanged ends. Angle valves 80 mm and larger shall conform to MSS SP-85 and shall be cast iron with bronze trim and flanged, or threaded ends.

##### 2.5.5.5 Ball Valves

Ball valves 15 mm and larger shall conform to MSS SP-72 or MSS SP-110, and shall be ductile iron or bronze with threaded, soldered, or flanged ends.

#### 2.5.5.6 Butterfly Valves

Butterfly valves shall be 2 flange or lug wafer type, and shall be bubble-tight at 1.03 MPa. Valve bodies shall be cast iron, malleable iron, or steel. ASTM A 167, Type 404 or Type 316, corrosion resisting steel stems, bronze or corrosion resisting steel discs, and synthetic rubber seats shall be provided. Valves smaller than 200 mm shall have throttling handles with a minimum of seven locking positions. Valves 200 mm and larger shall have totally enclosed manual gear operators with adjustable balance return stops and position indicators. Valves in insulated lines shall have extended neck to accommodate insulation thickness.

#### 2.5.5.7 Balancing Valves With Flow Measurement Taps.

Balancing valves 50 mm or smaller shall be bronze with NPT connections for black steel pipe and brazed connections for copper tubing. Valves 25 mm or larger may be all iron with threaded or flanged ends. The valves shall have a square head or similar device and an indicator arc and shall be designed for 120 degrees C. Iron valves shall be lubricated, nonlubricated, or tetrafluoroethylene resin-coated plug valves. Valves 200 mm or larger shall be provided with manual gear operators with position indicators. Valve bodies shall be provided with tapped openings and pipe extensions with shutoff valves outside of pipe insulation. The tapped openings shall be used for flow measurement. The pipe extensions shall be provided with quick connecting hose fittings for a portable meter to measure the pressure differential across the automatic flow control valve. One portable meter furnished with accessory kit as recommended by the automatic valve manufacturer shall be provided.

#### 2.5.5.8 Air Vents

Manual air vents shall be brass or bronze valves or cocks suitable for pressure rating of piping system and furnished with threaded plugs or caps. Automatic air vents shall be float type, cast iron, stainless steel, or forged steel construction, suitable for pressure rating of piping system.

#### 2.5.6 Strainers

Strainer shall be in accordance with ASTM F 1199, except as modified herein. Strainer shall be the cleanable, basket or "Y" type, the same size as the pipeline. The strainer bodies shall be fabricated of cast iron with bottoms drilled, and tapped. The bodies shall have arrows clearly cast on the sides indicating the direction of flow. Each strainer shall be equipped with removable cover and sediment screen. The screen shall be made of minimum 0.8 mm (22 gauge) brass sheet, with small perforations numbering not less than 60 per square centimeter to provide a net free area through the basket of at least 3,300 times that of the entering pipe. The flow shall be into the screen and out through the perforations.

#### 2.5.7 Chilled Water System Accessories

Chilled water system accessories such as pumps, combination strainer and suction diffusers, and expansion tanks shall be as specified in Section 15650 CENTRAL REFRIGERATED AIR CONDITIONING SYSTEM.

#### 2.5.8 Water Heating System Accessories

Water or steam heating accessories such as expansion tanks and steam traps shall be as specified in Section 15569 WATER AND STEAM HEATING; OIL, GAS OR BOTH; UP TO 20 MBTUH.

#### 2.5.9 Glycol

Glycol shall be of the type as listed for each of the two Chilled water plants. The glycol shall be tested according to ASTM D 1384 and shall cause less than 0.0125 mm penetration per year for all system metals. The glycol shall contain corrosion inhibitors. Silicon based inhibitors shall not be used. The solution shall be compatible with all wetted items within the system.

#### 2.5.10 Backflow Preventers

Backflow preventers shall be according to Section 15400 PLUMBING, GENERAL PURPOSE.

#### 2.5.11 Flexible Pipe Connectors

Flexible pipe connectors shall be designed for 862 kPa or 1034 kPa service as appropriate for the static head plus the system head, and 120 degrees C, 110 degrees C for grooved end flexible connectors. The flexible section shall be constructed of rubber, tetrafluoroethylene resin, or corrosion-resisting steel, bronze, monel, or galvanized steel. The flexible section shall be suitable for intended service with end connections to match adjacent piping. Flanged assemblies shall be equipped with limit bolts to restrict maximum travel to the manufacturer's standard limits. Unless otherwise indicated, the length of the flexible connectors shall be as recommended by the manufacturer for the service intended. Internal sleeves or liners, compatible with circulating medium, shall be provided when recommended by the manufacturer. Covers to protect the bellows shall be provided where indicated.

#### 2.5.12 Pressure Gauges

Gauges shall conform to ASME B40.1 and shall be provided with throttling type needle valve or a pulsation damper and shut-off valve. Gauge shall be a minimum of 85 mm in diameter and shall have a range from 0 kPa to approximately 1.5 times the maximum system working pressure.

#### 2.5.13 Thermometers

Thermometers shall have brass, malleable iron, or aluminum alloy case and frame, clear protective face, permanently stabilized glass tube with indicating-fluid column, white face, black numbers, and a 225 mm scale, and shall have rigid stems with straight, angular, or inclined pattern.

#### 2.5.14 Escutcheons

Escutcheons shall be chromium-plated iron or chromium-plated brass, either one piece or split pattern, held in place by internal spring tension or setscrews.

#### 2.5.15 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69.

#### 2.5.16 Insulation

Shop and field applied insulation shall be as specified in Section 15250 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

#### 2.5.17 Condensate Drain Lines

Condensate drainage shall be provided for each item of equipment that generates condensate as specified for drain, waste, and vent piping systems in Section 15400 PLUMBING, GENERAL PURPOSE.

### 2.6 ELECTRICAL WORK

Electrical motor-driven equipment specified shall be provided complete with motor, motor starter, and controls. Unless otherwise specified, electric equipment, including wiring and motor efficiencies, shall be according to Section 16415 ELECTRICAL WORK, INTERIOR. Electrical characteristics and enclosure type shall be as shown. Unless otherwise indicated, motors of 745 W and above shall be high efficiency type. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary. Each motor shall be according to NEMA MG 1 and shall be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Manual or automatic control and protective or signal devices required for the operation specified, and any control wiring required for controls and devices, but not shown, shall be provided. Where two-speed or variable-speed motors are indicated, solid-state variable-speed controller may be provided to accomplish the same function. Solid-state variable-speed controllers shall be utilized for motors rated 7.45 kW (10 hp) or less. Adjustable frequency drives shall be used for larger motors.

### 2.7 CONTROLS

Controls shall be provided as specified in Section 15950 HEATING, VENTILATING AND AIR CONDITIONING (HVAC) CONTROL SYSTEMS.

### 2.8 DUCTWORK COMPONENTS

#### 2.8.1 Metal Ductwork

All aspects of metal ductwork construction, including all fittings and components, shall comply with SMACNA-06 unless otherwise specified. Elbows shall be radius type with a centerline radius of 1-1/2 times the width or diameter of the duct where space permits. Otherwise, elbows having a minimum radius equal to the width or diameter of the duct or square elbows with factory fabricated turning vanes may be used. Static pressure Class 125, 250, and 500 Pa ductwork shall meet the requirements of Seal Class A. Class 750 through 2500 Pa shall meet the requirements of Seal Class A. Sealants shall conform to fire hazard classification specified in Section 15250 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Pressure sensitive tape shall not be used as a sealant. Spiral lock seam duct, and flat oval shall be made with duct sealant and locked with not less than 3 equally spaced



drive screws or other approved methods indicated in SMACNA-06. The sealant shall be applied to the exposed male part of the fitting collar so that the sealer will be on the inside of the joint and fully protected by the metal of the duct fitting. One brush coat of the sealant shall be applied over the outside of the joint to at least 50 mm band width covering all screw heads and joint gap. Dents in the male portion of the slip fitting collar will not be acceptable. Outdoor air intake ducts and plenums shall be fabricated with watertight soldered or brazed joints and seams.

#### 2.8.1.1 Transitions

Diverging air flow transitions shall be made with each side pitched out a maximum of 15 degrees, for an included angle of 30 degrees. Transitions for converging air flow shall be made with each side pitched in a maximum of 30 degrees, for an included angle of 60 degrees, or shall be as indicated. Factory-fabricated reducing fittings for systems using round duct sections when formed to the shape of the ASME short flow nozzle, need not comply with the maximum angles specified.

#### 2.8.1.2 Metallic Flexible Duct for Final Connection to Clothes Dryers Only

Metallic type duct shall be single-ply Type 316 stainless steel. Duct shall be of corrugated/interlocked, folded and knurled type seam construction, bendable without damage through 180 degrees with a throat radius equal to 1/2 duct diameter. Duct shall conform to UL 181 and shall be rated for positive or negative working pressure of 250 Pa at 65 degrees C.

#### 2.8.1.3 Insulated Nonmetallic Flexible Duct Runouts

Flexible duct runouts shall be used only where indicated. Runout length shall be as shown on the drawings, but shall in no case exceed 3 m. Runouts shall be preinsulated, factory fabricated, and shall comply with NFPA 90A and UL 181. Either field or factory applied vapor barrier shall be provided. Where coil induction or high velocity units are supplied with vertical air inlets, a streamlined and vaned and mitered elbow transition piece shall be provided for connection to the flexible duct or hose. The last elbow to these units, other than the vertical air inlet type, shall be a die-stamped elbow and not a flexible connector. Insulated flexible connectors may be used as runouts. The insulated material and vapor barrier shall conform to the requirements of Section 15250 THERMAL INSULATION FOR MECHANICAL SYSTEMS. The insulation material surface shall not be exposed to the air stream.

#### 2.8.1.4 General Service Duct Connectors

A flexible duct connector approximately 150 mm in width shall be provided where sheet metal connections are made to fans or where ducts of dissimilar metals are connected. For round/oval ducts, the flexible material shall be secured by stainless steel or zinc-coated, iron clinch-type draw bands. For rectangular ducts, the flexible material locked to metal collars shall be installed using normal duct construction methods. The composite connector system shall comply with UL 214 and be classified as "flame-retarded fabrics" in UL-01.

#### 2.8.1.5 High Temperature Service Duct Connections

Material shall be approximately 2.38 mm thick, 1.2 to 1.36 kg per square meter weight, plain weave fibrous glass cloth with, nickel/chrome wire reinforcement for service in excess of 650 degrees C.

#### 2.8.2 Ductwork Accessories

##### 2.8.2.1 Duct Access Doors

Access doors shall be provided in ductwork and plenums where indicated and at all air flow measuring primaries, automatic dampers, fire dampers, coils, thermostats, and other apparatus requiring service and inspection in the duct system, and unless otherwise shown, shall conform to SMACNA-06. Access doors shall be provided upstream and downstream of air flow measuring primaries and heating and cooling coils. Doors shall be minimum 375 x 450 mm, unless otherwise shown. Where duct size will not accommodate this size door, the doors shall be made as large as practicable. Doors 600 x 600 mm or larger shall be provided with fasteners operable from both sides. Doors in insulated ducts shall be the insulated type.

##### 2.8.2.2 Fire Dampers

Fire dampers shall be 1-1/2 hour fire rated unless otherwise indicated. Fire dampers shall conform to the requirements of NFPA 90A and UL 555. Fire dampers shall be automatic operating type and shall have a dynamic rating suitable for the maximum air velocity and pressure differential to which it will be subjected. Fire dampers shall be approved for the specific application, and shall be installed according to their listing. Fire dampers shall be equipped with a steel sleeve or adequately sized frame installed in such a manner that disruption of the attached ductwork, if any, will not impair the operation of the damper. Sleeves or frames shall be equipped with perimeter mounting angles attached on both sides of the wall or floor opening. Ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce the ceiling of the assemblies shall be constructed in conformance with UL-05. Fire dampers shall be out of the air stream multi-blade type. Dampers shall not reduce the duct or the air transfer opening cross-sectional area. Dampers shall be installed so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition or floor slab depth or thickness. Unless otherwise indicated, the installation details given in SMACNA-05 and in manufacturer's instructions for fire dampers shall be followed.

##### 2.8.2.3 Manual Balancing Dampers

Manual balancing dampers shall be furnished with accessible operating mechanisms. Where operators occur in finished portions of the building, operators shall be chromium plated with all exposed edges rounded. Manual volume control dampers shall be operated by locking-type quadrant operators. Dampers shall be 2 gauges heavier than the duct in which installed. Unless otherwise indicated, multileaf dampers shall be opposed blade type with maximum blade width of 300 mm. Access doors or panels shall be provided for all concealed damper operators and locking setscrews. Unless otherwise indicated, the locking-type quadrant operators for dampers, when installed on ducts to be thermally insulated, shall be provided with stand-off mounting brackets, bases, or adapters to provide clearance between the duct surface and the operator not less than the thickness of the insulation.

Stand-off mounting items shall be integral with the operator or standard accessory of the damper manufacturer. Volume dampers shall be provided where indicated.

### 2.8.3 Duct Sleeves, Framed Prepared Openings, Closure Collars

#### 2.8.3.1 Duct Sleeves

Duct sleeves shall be provided for round ducts 375 mm in diameter or less passing through floors, walls, ceilings, or roof, and installed during construction of the floor, wall, ceiling, or roof. Round ducts larger than 375 mm in diameter and square, rectangular, and oval ducts passing through floors, walls, ceilings, or roof shall be installed through framed prepared openings. The Contractor shall be responsible for the proper size and location of sleeves and prepared openings. Sleeves and framed openings are also required where grilles, registers, and diffusers are installed at the openings. Framed prepared openings shall be fabricated from 1.0 mm (20 gauge) galvanized steel, unless otherwise indicated. Where sleeves are installed in bearing walls or partitions, black steel pipe, ASTM A 53, Schedule 20 shall be used. Sleeve shall provide 25 mm clearance between the duct and the sleeve or 25 mm clearance between the insulation and the sleeve for insulated ducts.

#### 2.8.3.2 Framed Prepared Openings

Openings shall have 25 mm clearance between the duct and the opening or 25 mm clearance between the insulation and the opening for insulated ducts.

#### 2.8.3.3 Closure Collars

Collars shall be fabricated of galvanized sheet metal not less than 100 mm wide, unless otherwise indicated, and shall be installed on exposed ducts on each side of walls or floors where sleeves or prepared openings are provided. Collars shall be installed tight against surfaces. Collars shall fit snugly around the duct or insulation. Sharp edges of the collar around insulated duct shall be ground smooth to preclude tearing or puncturing the insulation covering or vapor barrier. Collars for round ducts 375 mm in diameter or less shall be fabricated from 1.0 mm (20 gauge) galvanized steel. Collars for round ducts larger than 375 mm and square, and rectangular ducts shall be fabricated from 1.3 mm (18 gauge) galvanized steel. Collars shall be installed with fasteners on maximum 150 mm centers, except that not less than 4 fasteners shall be used.

#### 2.8.3.4 Duct Liner

Unless otherwise specified, duct liner shall conform to ASTM C 1071, Type I or II.

### 2.8.4 Sound Attenuation Equipment

- a. System With Total Pressure of 1000 Pa (4 Inch Water Gauge) and Lower:

Sound attenuators shall be provided only where indicated, or in lieu of lined ducts. Factory fabricated sound attenuators shall be constructed of galvanized steel sheets. Outer casing shall be not less than 0.85 mm (22 gauge). Acoustical fill shall be fibrous glass. Net sound reduction shall

be as indicated. Values shall be obtained on a test unit not less than 600 mm by 600 mm outside dimensions made by a certified nationally recognized independent acoustical laboratory. Air flow capacity shall be as indicated or required. Pressure drop through the attenuator shall not exceed the value indicated, or shall not be in excess of 15 percent of the total external static pressure of the air handling system, whichever is less. Sound attenuators shall be acoustically tested with metal duct inlet and outlet sections while under the rated air flow conditions. Noise reduction data shall include the effects of flanking paths and vibration transmission. Sound attenuators shall be constructed to be airtight when operating at the internal static pressure indicated or specified for the duct system, but in no case less than 500 Pa.

a. Acoustical Duct Liner:

Acoustical duct lining shall be fibrous glass designed exclusively for lining ductwork and shall conform to the requirements of ASTM C 1071, Type I and II. Liner composition may be uniform density, graduated density, or dual density, as standard with the manufacturer. Lining shall be coated, not less than 50 mm thick. Where acoustical duct liner is used, liner or combination of liner and insulation applied to the exterior of the ductwork shall be the thermal equivalent of the insulation specified in Section 15250 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Duct sizes shown shall be increased to compensate for the thickness of the lining used.

#### 2.8.5 Diffusers, Registers, and Grilles

Units shall be factory-fabricated of steel, corrosion-resistant steel, or aluminum and shall distribute the specified quantity of air evenly over space intended without causing noticeable drafts, air movement faster than 0.25 m/s in occupied zone, or dead spots anywhere in the conditioned area. Outlets for diffusion, spread, throw, and noise level shall be as required for specified performance. Performance shall be certified according to ASHRAE 70. Inlets and outlets shall be sound rated and certified according to ASHRAE 70. Sound power level shall be as indicated. Diffusers and registers shall be provided with volume damper with accessible operator, unless otherwise indicated; or if standard with the manufacturer, an automatically controlled device will be acceptable. Volume dampers shall be opposed blade type for all diffusers and registers, except linear slot diffusers. Linear slot diffusers shall be provided with round or elliptical balancing dampers. Where the inlet and outlet openings are located less than 2 m above the floor, they shall be protected by a grille or screen according to NFPA 90A.

##### 2.8.5.1 Diffusers

Diffuser types shall be as indicated. Ceiling mounted units shall be furnished with anti-smudge devices, unless the diffuser unit minimizes ceiling smudging through design features. Diffusers shall be provided with air deflectors of the type indicated. Ceiling mounted units shall be installed with rims tight against ceiling. Sponge rubber gaskets shall be provided between ceiling and surface mounted diffusers for air leakage control. Suitable trim shall be provided for flush mounted diffusers. Duct collar connecting the duct to diffuser shall be airtight and shall not interfere with volume controller.

#### 2.8.5.2 Registers and Grilles

Units shall be four-way directional-control type. Registers shall be provided with sponge-rubber gasket between flanges and duct. Wall supply registers shall be installed at least 150 mm below the ceiling unless otherwise indicated. Four-way directional control may be achieved by a grille face which can be rotated in 4 positions or by adjustment of horizontal and vertical vanes.

#### 2.8.6 Louvers

Louvers for installation in exterior walls which are associated with the air supply and distribution system shall be as specified in Section 07600 SHEET METALWORK, GENERAL and as shown by the architectural portions of the project documents.

#### 2.8.7 Bird Screens and Frames

Bird screens shall conform to ASTM E 437, Type I, Class 1, 2 by 2 mesh, 1.6 mm diameter aluminum wire or 0.8 mm inch diameter stainless steel wire. Frames shall be removable type or stainless steel or extruded aluminum.

### 2.9 AIR SYSTEMS EQUIPMENT

#### 2.9.1 Fans

Fans shall be tested and rated according to AMCA 210. Fans may be connected to the motors either directly or indirectly with V-belt drive. V-belt drives shall be designed for not less than 150 percent of the connected driving capacity. Motor sheaves shall be variable pitch for 11 kW (15 hp) and below and fixed pitch as defined by ARI Guideline D. Variable pitch sheaves shall be selected to drive the fan at a speed which will produce the specified capacity when set at the approximate midpoint of the sheave adjustment. When fixed pitch sheaves are furnished, a replaceable sheave shall be provided when needed to achieve system air balance. Motors for V-belt drives shall be provided with adjustable rails or bases. Removable metal guards shall be provided for all exposed V-belt drives, and speed-test openings shall be provided at the center of all rotating shafts. Fans shall be provided with personnel screens or guards on both suction and supply ends, except that the screens need not be provided, unless otherwise indicated, where ducts are connected to the fan. Fan and motor assemblies shall be provided with vibration-isolation supports or mountings as indicated. Vibration-isolation units shall be standard products with published loading ratings. Each fan shall be selected to produce the capacity required at the fan static pressure indicated. Sound power level shall be as indicated. The sound power level values shall be obtained according to AMCA 300. Standard AMCA arrangement, rotation, and discharge shall be as indicated.

##### 2.9.1.1 Centrifugal Fans

Centrifugal fans shall be fully enclosed, single-width single-inlet, or double-width double-inlet, AMCA Pressure Class I, II, or III as required or indicated for the design system pressure. Impeller wheels shall be rigidly constructed, accurately balanced both statically and dynamically. Fan blades may be forward curved, backward-inclined or airfoil design in wheel sizes up to 750 mm. Fan blades for wheels over 750 mm in diameter shall be

backward-inclined or airfoil design. Fan wheels over 900 mm in diameter shall have overhung pulleys and a bearing on each side of the wheel. Fan wheels 900 mm or less in diameter may have one or more extra long bearings between the fan wheel and the drive. Bearings shall be sleeve type, self-aligning and self-oiling with oil reservoirs, or precision self-aligning roller or ball-type with accessible grease fittings or permanently lubricated type. Grease fittings shall be connected to tubing and serviceable from a single accessible point. Bearing life shall be L50 rated at not less than 200,000 hours as defined by ABEMA 9 and ABEMA 11. Fan shafts shall be steel, accurately finished, and shall be provided with key seats and keys for impeller hubs and fan pulleys. Each fan outlet shall be of ample proportions and shall be designed for the attachment of angles and bolts for attaching flexible connections. Motors, unless otherwise indicated, shall not exceed 1800 rpm and shall have dripproof enclosures. Motor starters shall be manual or across-the-line type with general-purpose enclosure.

#### 2.9.1.2 In-Line Centrifugal Fans

In-line fans shall have centrifugal backward inclined blades, stationary discharge conversion vanes, internal and external belt guards, and adjustable motor mounts. Fans shall be mounted in a welded tubular casing. Air shall enter and leave the fan axially. Inlets shall be streamlined with conversion vanes to eliminate turbulence and provide smooth discharge air flow. Fan bearings and drive shafts shall be enclosed and isolated from the air stream. Fan bearings shall be sealed against dust and dirt and shall be permanently lubricated, and shall be precision self aligning ball or roller type. Bearing life shall be L50 rated at not less than 200,000 hours as defined by ABEMA 9 and ABEMA 11. Motors shall have dripproof enclosure. Motor starters shall be manual with general-purpose enclosures.

#### 2.9.1.3 Panel Type Power Wall Ventilators

Fans shall be propeller type, assembled on a reinforced metal panel with venturi opening spun into panel. Fans with wheels less than 600 mm diameter shall be direct or V-belt driven and fans with wheels 600 mm diameter and larger shall be V-belt drive type. Fans shall be furnished with wall mounting collar. Lubricated bearings shall be provided. Fans shall be fitted with wheel and motor side metal or wire guards which have a corrosion-resistant finish. Motor enclosure shall be [dripproof] [totally enclosed fan cooled] [explosion-proof] type. [Gravity] [Motor operated] backdraft dampers shall be provided where indicated.

#### 2.9.1.4 Propeller Type Power Roof Ventilators

Fans shall be direct or V-belt driven. Fan housing shall be hinged or removable weathertight, fitted with framed rectangular base constructed of aluminum or galvanized steel. Motors shall be totally enclosed fan cooled type. Motors shall be provided with non-fusible, horsepower rated, manual disconnect mount on unit. Fans shall be provided with motor operated dampers, bird screen. Lubricated bearings shall be provided.

#### 2.9.2 Coils

Coils shall be fin-and-tube type constructed of seamless copper tubes and aluminum or copper fins mechanically bonded or soldered to the tubes. Copper tube wall thickness shall be a minimum of 0.508 mm. Aluminum fins

shall be 0.19 mm minimum thickness. Copper fins shall be 0.114 mm minimum thickness. Casing and tube support sheets shall be not lighter than 1.6 mm (16 gauge) galvanized steel, formed to provide structural strength. When required, multiple tube supports shall be provided to prevent tube sag. Each coil shall be tested at the factory under water at not less than 2.76 MPa air pressure and shall be suitable for 1.38 MPa working pressure. Coils shall be mounted for counterflow service. Coils shall be rated and certified according to ARI 410.

#### 2.9.2.1 Water Coils

Water coils shall be installed with a pitch of not less than 10 mm per meter of the tube length toward the drain end. Headers shall be constructed of cast iron, welded steel or copper. Each coil shall be provided with a plugged vent and drain connection extending through the unit casing.

#### 2.9.3 Air Filters

Air filters shall be listed according to requirements of UL 900, except high efficiency particulate air filters of 99.97 percent efficiency by the DOP Test method shall be as listed under the Label Service and shall meet the requirements of UL 586.

##### 2.9.3.1 Extended Surface Pleated Panel Filters

Filters shall be 50 mm depth, sectional, disposable type of the size indicated and shall have an average efficiency of 25 to 30 percent when tested according to ASHRAE 52.1. Initial resistance at 2.54 m/s shall not exceed 9 mm water gauge. Filters shall be UL Class 2. Media shall be nonwoven cotton and synthetic fiber mat. A wire support grid bonded to the media shall be attached to a moisture resistant fiberboard frame. All four edges of the filter media shall be bonded to the inside of the frame to prevent air bypass and increase rigidity.

##### 2.9.3.2 Holding Frames

Frames shall be fabricated from not lighter than 1.6 mm (16 gauge) sheet steel with rust-inhibitor coating. Each holding frame shall be equipped with suitable filter holding devices. Holding frame seats shall be gasketed. All joints shall be airtight.

##### 2.9.3.3 Filter Gauges

Filter gauges shall be dial type, diaphragm actuated draft and shall be provided for all filter stations, including those filters which are furnished as integral parts of factory fabricated air handling units. Gauges shall be at least 98 mm in diameter, shall have white dials with black figures, and shall be graduated in 0.25 mm and shall have a minimum range of 25 mm beyond the specified final resistance for the filter bank on which each gauge is applied. Each gauge shall incorporate a screw operated zero adjustment and shall be furnished complete with two static pressure tips with integral compression fittings, two molded plastic vent valves, two 1.5 m minimum lengths of 6.35 mm diameter aluminum tubing, and all hardware and accessories for gauge mounting.

## 2.10 AIR HANDLING UNITS

### 2.10.1 Factory-Fabricated Air Handling Units

Units shall be single-zone draw-through type as indicated. Units shall include fans, coils, airtight insulated casing, filter sections, adjustable V-belt drives, belt guards for externally mounted motors, access sections where indicated, combination filter (low velocity configuration) and mixing box without integral dampers, vibration-isolators, and other sections and appurtenances required for specified operation. Vibration isolators shall be as indicated. Each air handling unit shall have physical dimensions suitable to fit space allotted to the unit and shall have the capacity indicated. Air handling unit shall have published ratings based on tests performed according to ARI 430.

#### 2.10.1.1 Casings

Casing sections shall be 2 inch double wall type constructed of a minimum 18 gauge galvanized steel, or 18 gauge steel outer casing protected with a corrosion resistant paint finish according to paragraph FACTORY PAINTING. Inner casing of double-wall units shall be minimum 1.0 mm solid galvanized steel. Casing shall be designed and constructed with an integral structural steel frame such that exterior panels are non-load bearing. Exterior panels shall be individually removable. Removal shall not affect the structural integrity of the unit. Casings shall be provided with inspection doors, access sections, and access doors as indicated. Inspection and access doors shall be insulated, fully gasketed, double-wall type, of a minimum 1.3 mm outer and 1.0 mm inner panels. Doors shall be rigid and provided with heavy duty hinges and latches. Inspection doors shall be a minimum 300 mm wide by 300 mm high. Access doors shall be minimum 600 mm wide and shall be the full height of the unit casing or a minimum of 1800 mm, whichever is less. A minimum 200 mm by 200 mm sealed glass window suitable for the intended application shall be installed in all fan and drive section access doors. Access Sections shall be according to paragraph AIR HANDLING UNITS. Drain pan shall be double-bottom type constructed of 16 gauge galvanized steel, pitched to the drain connection. Drain pans shall be constructed water tight, treated to prevent corrosion, and designed for positive condensate drainage. When 2 or more cooling coils are used, with one stacked above the other, condensate from the upper coils shall not flow across the face of lower coils. Intermediate drain pans or condensate collection channels and downspouts shall be provided, as required to carry condensate to the unit drain pan out of the air stream and without moisture carryover. Each casing section handling conditioned air shall be insulated with not less than 25 mm thick, 24 kg per cubic meter coated fibrous glass material having a thermal conductivity not greater than 0.033 W/m-K. Factory fibrous glass insulation shall conform to ASTM C 1071, except that the minimum thickness and density requirements do not apply, and shall meet the requirements of NFPA 90A. Foam-type insulation is not acceptable. Foil-faced insulation shall not be an acceptable substitute for use on double-wall access doors and inspections doors and casing sections. Duct liner material, coating, and adhesive shall conform to fire-hazard requirements specified in Section 15250 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Exposed insulation edges and joints where insulation panels are butted together shall be protected with a metal nosing strip or shall be coated to conform to meet erosion resistance requirements of ASTM C 1071. A latched and hinged inspection door with safety fan interlock switch, shall be provided in fan sections. Additional



inspection doors, access doors and access sections shall be provided as shown.

#### 2.10.1.2 Heating and Cooling Coils

Coils shall be provided as specified in paragraph AIR SYSTEMS EQUIPMENT, for types indicated.

#### 2.10.1.3 Air Filters

Air filters shall be as specified in paragraph AIR SYSTEMS EQUIPMENT for types and thickness indicated.

#### 2.10.1.4 Fans

Fans shall be double-inlet, centrifugal type with each fan in a separate scroll. Fans and shafts shall be dynamically balanced prior to installation into air handling unit, then the entire fan assembly shall be statically and dynamically balanced at the factory after it has been installed in the air handling unit. Fans shall be mounted on steel shafts accurately ground and finished. Fan bearings shall be sealed against dust and dirt and shall be precision self-aligning ball or roller type. Bearing life shall be L50 rated at not less than 200,000 hours as defined by ABEMA 9 and ABEMA 11. Bearings shall be permanently lubricated or lubricated type with lubrication fittings readily accessible at the drive side of the unit. Bearings shall be supported by structural shapes, or die formed sheet structural members, or support plates securely attached to the unit casing. Bearings may not be fastened directly to the unit sheet metal casing. Fans and scrolls shall be furnished with coating indicated. Fans shall be driven by a unit-mounted or a floor-mounted motor connected to fans by V-belt drive complete with belt guard for externally mounted motors. Belt guards shall be the three sided enclosed type with solid or expanded metal face. Belt drives shall be designed for not less than a 1.3 service factor based on motor nameplate rating. Motor sheaves shall be variable pitch for 20 kW and below and fixed pitch above 20 kW as defined by ARI Guideline D. Where fixed sheaves are required, variable pitch sheaves may be used during air balance, but shall be replaced with an appropriate fixed sheave after air balance is completed. Variable pitch sheaves shall be selected to drive the fan at a speed that will produce the specified capacity when set at the approximate midpoint of the sheave adjustment. Motors for V-belt drives shall be provided with adjustable bases. Fan motors shall have open enclosures. Motor starters shall be manual across-the-line type with general-purpose enclosure. Unit fan or fans shall be selected to produce the required capacity at the fan static pressure. Sound power level shall be as indicated. The sound power level values shall be obtained according to AMCA 300 or ASHRAE 68.

#### 2.10.1.5 Access Sections and Filter/Mixing Boxes

Access sections shall be provided where indicated and shall be furnished with access doors as shown. Access sections and filter/mixing boxes shall be constructed in a manner identical to the remainder of the unit casing and shall be equipped with access doors. Mixing boxes shall be designed to minimize air stratification and to promote thorough mixing of the air streams.

#### 2.10.1.6 Dampers

Dampers shall be as specified in paragraph CONTROLS.

### 2.11 TERMINAL UNITS

#### 2.11.1 Room Fan-Coil Units

Base units shall include galvanized coil casing, coil assembly drain pan valve and piping package, air filter, fans, motor, fan drive, and motor switch, plus an enclosure for cabinet models and casing for concealed models. Leveling devices integral with the unit shall be provided for vertical type units. Sound power levels shall be as indicated. Sound power level data or values for these units shall be obtained according to test procedures based on ARI 350. Sound power values apply to units provided with factory fabricated cabinet enclosures and standard grilles. Values obtained for the standard cabinet models will be acceptable for concealed models without separate test provided there is no variation between models as to the coil configuration, blowers, motor speeds, or relative arrangement of parts. Automatic valves and controls shall be provided as specified in paragraph CONTROLS. Each unit shall be fastened securely to the building structure. Capacity of the units shall be as indicated. Room fan-coil units shall be certified as complying with ARI 440, and shall meet the requirements of UL 1995.

##### 2.11.1.1 Enclosures

Enclosures shall be fabricated of not lighter than 1.3 mm (18 gauge) steel, reinforced and braced. Front panels of enclosures shall be removable and provided with 13 mm thick dual density fibrous glass insulation. The exposed side shall be high density, erosion-proof material suitable for use in air streams with velocities up to 23 m/s. Ferrous metal surfaces shall be galvanized or factory finished with corrosion resistant enamel. Access doors or removable panels shall be provided for piping and control compartments. Duct discharge collar shall be provided for concealed models. Enclosures shall have easy access for filter replacement.

##### 2.11.1.2 Fans

Fans shall be galvanized steel or aluminum, multiblade, centrifugal type. In lieu of metal, fans and scrolls may be non-metallic materials of suitably reinforced compounds. Fans shall be dynamically and statically balanced. Surfaces shall be smooth. Assemblies shall be accessible for maintenance. Disassembly and re-assembly shall be by means of mechanical fastening devices and not by epoxies or cements.

##### 2.11.1.3 Coils

Coils shall be constructed of not less than 10 mm outside diameter seamless copper tubing, with copper or aluminum fins mechanically bonded or soldered to the tubes. Coils shall be provided with not less than 12 mm outside diameter flare or sweat connectors, accessory piping package with thermal connections suitable for connection to the type of control valve supplied, and manual air vent. Coils shall be tested hydrostatically at 2000 kPa or under water at 1700 kPa air pressure and suitable for 1400 kPa working pressure. Provisions shall be made for coil removal.

## 2.11.1.4 Drain Pans

Drain and drip pans shall be sized and located to collect all water condensed on and dripping from any item within the unit enclosure or casing. Drain pans shall be constructed of not lighter than 0.9 mm (21 gauge) steel, galvanized after fabrication, thermally insulated to prevent condensation. Insulation shall have a flame spread rating not over 25 without evidence of continued progressive combustion, a smoke developed rating no higher than 50, and shall be of a waterproof type or coated with a waterproofing material. In lieu of the above, drain pans may be constructed of die-formed 0.85 mm (22 gauge) steel, formed from a single sheet, galvanized after fabrication, insulated and coated as specified for the 0.9 mm (21 gauge) material or of die-formed 0.9 mm (21 gauge) type 304 stainless steel, insulated as specified above. Drain pans shall be pitched to drain. Minimum 20 mm NPT or 15 mm OD drain connection shall be provided in drain pan. Auxiliary drain pans to catch drips from control and piping packages, eliminating insulation of the packages, may be plastic; if metal, the auxiliary pans shall comply with the requirements specified above. Insulation at control and piping connections thereto shall extend 25 mm minimum over the auxiliary drain pan.

## 2.11.1.5 Filters

Filters shall be of the fiberglass disposable type, 25 mm thick, conforming to CID A-A-1419. Filters in each unit shall be removable without the use of tools. Filter retainers, seals and access doors and all of the fasteners for these items shall both be captively attached to the unit cabinet. Filter removal shall be done using no tools or simple, widely available tools, such as a screwdriver.

## 2.11.1.6 Motors

Motors shall be of the permanent split-capacitor type with built-in thermal overload protection, directly connected to unit fans. Motor switch shall be three speeds and off, manually operated, and shall be mounted on an identified plate adjacent to the room thermostat. Motors shall have permanently-lubricated or oilable sleeve-type or combination ball and sleeve-type bearings with vibration isolating mountings suitable for continuous duty. Motor power consumption, shown in watts, at the fan operating speed selected to meet the specified capacity shall not exceed the following values:

Unit Capacity (L/s)	Maximum Power Consumption (Watts)
94	55
142	60
189	65
283	80
378	130
472	130
566	130

## 2.12 FACTORY PAINTING

Units which are not of galvanized construction according to ASTM A 123 or ASTM A 924 shall be factory painted with a corrosion resisting paint finish. Internal and external ferrous metal surfaces shall be cleaned, phosphatised and coated with a paint finish which has been tested according to ASTM B 117, ASTM D 1654, and ASTM D 3359. Evidence of satisfactory paint performance for a minimum of 125 hours for units to be installed indoors and 500 hours for units to be installed outdoors shall be submitted. Rating of failure at the scribe mark shall be not less than 6, average creepage not greater than 3 mm. Rating of the inscribed area shall not be less than 10, no failure. On units constructed of galvanized steel which have been welded, exterior surfaces of welds or welds that have burned through from the interior shall receive a final shop docket of zinc-rich protective paint according to ASTM D 520 Type I.

## 3 EXECUTION

### 3.1 INSTALLATION

Work shall be installed as shown and according to the manufacturer's diagrams and recommendations.

#### 3.1.1 Piping

Pipe and fitting installation shall conform to the requirements of ASME B31.1. Pipe shall be cut accurately to measurements established at the jobsite, and worked into place without springing or forcing, completely clearing all windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted without written approval. Pipe or tubing shall be cut square, shall have burrs removed by reaming, and shall permit free expansion and contraction without causing damage to the building structure, pipe, joints, or hangers. Changes in direction shall be made with fittings, except that bending of pipe 100 mm (4 inches) and smaller will be permitted, provided a pipe bender is used and wide sweep bends are formed. The centerline radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted. Horizontal supply mains shall pitch down in the direction of flow as indicated. The grade shall be not less than 2 mm in 1 m. Reducing fittings shall be used for changes in pipe sizes. Open ends of pipelines and equipment shall be capped or plugged during installation to keep dirt or other foreign materials out of the system. Pipe not otherwise specified shall be uncoated. Connections to appliances shall be made with malleable iron unions for steel pipe 65 mm or less in diameter, and with flanges for pipe 80 mm and larger. Connections between ferrous and copper piping shall be electrically isolated from each other with dielectric unions or flanges. All piping located in air plenums shall conform to NFPA 90A requirements. Pipe and fittings installed in inaccessible conduits or trenches under concrete floor slabs shall be welded.

##### 3.1.1.1 Joints

- a. Threaded Joints: Threaded joints shall be made with tapered threads and made tight with a stiff mixture of graphite and oil or polytetrafluoroethylene tape or equivalent thread joint compound or material, applied to the male threads only.

- b. Soldered Joints: Joints in copper tubing shall be cut square with ends reamed, and all filings and dust wiped from interior of pipe. Joints shall be soldered with 95/5 solder or brazed with silver solder applied and drawn through the full fitting length. Care shall be taken to prevent annealing of tube or fittings when making connections. Joints 65 mm and larger shall be made with heat uniformly around the entire circumference of the joint with a multi-flame torch. Connections in floor slabs shall be brazed. Excess solder shall be wiped from joint before solder hardens.
- c. Welded Joints: Welding shall be according to qualified procedures using qualified welders and welding operators. Procedures and welders shall be qualified according to ASME BPV IX. Welding procedures qualified by others and welders and welding operators qualified by another operator may be permitted by ASME B31.1. Structural members shall be welded according to Section 05055 WELDING, STRUCTURAL. All welds shall be permanently identified by imprinting the welder's or welding operator's assigned symbol adjacent to the weld. Welded joints shall be fusion welded unless otherwise required. Changes in direction of piping shall be made with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be permitted. Branch connections may be made with either welding tees or branch outlet fittings. Branch outlet fittings shall be forged, flared for improvement of flow where attached to the run, and reinforced against external strains. Beveling, alignment, heat treatment and inspection of weld shall conform to ASME B31.1. Weld defects shall be removed and repairs made to the weld, or the weld joints shall be entirely removed and rewelded. Electrodes shall be stored and dried according to AWS D1.1 or as recommended by the manufacturer. Electrodes that have been wetted or that have lost any of their coating shall not be used.

#### 3.1.1.2 Grooved Mechanical Joints

Grooves shall be prepared according to the coupling manufacturer's instructions. Pipe and groove dimensions shall comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field shall be measured using a "go/no-go" gauge, vernier or dial caliper, or narrow-land micrometer. Groove width and dimension of groove from end of pipe shall be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints shall not be used in concealed locations.

#### 3.1.1.3 Flanges and Unions

Except where copper tubing is used, union or flanged joints shall be provided in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control valves, and other similar items.

### 3.1.2 Supports

#### 3.1.2.1 General

Hangers used to support piping 50 mm and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Pipe guides and anchors shall be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Piping subjected to vertical movement when operating temperatures exceed ambient temperatures shall be supported by variable spring hangers and supports or by constant support hangers.

#### 3.1.2.2 Seismic Requirements (Pipe Supports and Structural Bracing)

Piping and attached valves shall be supported and braced to resist seismic loads as specified under Section 13080 SEISMIC PROTECTION FOR MECHANICAL, ELECTRICAL EQUIPMENT and as shown on the drawings. Structural steel required for reinforcement to properly support piping, headers, and equipment but not shown shall be provided under this section. Material used for support shall be as specified under Section 05210 STEEL JOISTS.

#### 3.1.2.3 Pipe Hangers, Inserts and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69, except as modified herein. Types 5, 12, and 26 shall not be used.

- a. Hangers: Type 3 shall not be used on insulated piping.
- b. Inserts: Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for Type 18 inserts.
- c. C-Clamps: Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.
- d. Angle Attachments: Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.
- e. Hangers: Type 24 may be used only on trapeze hanger systems or on fabricated frames.
- f. Type 39 saddles shall be used on all insulated pipe 100 mm and larger when the temperature of the medium is above 15.5 degrees C. Type 39 saddles shall be welded to the pipe.
- g. Type 40 shields shall:
  - (1) be used on all insulated pipes less than 100 mm.
  - (2) be used on all insulated pipes 100 mm and larger when the temperature of the medium is 15.5 degrees C or less.

- (3) have a high density insert for pipe 50 mm (2 inches) and larger, and for smaller pipe when the insulation shows signs of being visibly compressed, or when the insulation or jacket shows visible signs of distortion at or near the type 40 shield. High density inserts shall have a density of 144 kg/cubic meter (9 pcf) or greater.
- h. Horizontal Pipe Supports: Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 300 mm (1 foot) from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 1.5 m apart at valves. Pipe hanger loads suspended from steel joist with hanger loads between panel points in excess of 220 N shall have the excess hanger loads suspended from panel points.
  - i. Vertical Pipe Supports: Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 5 m, not more than 2.4 m from end of risers, and at vent terminations.
  - j. Pipe Guides: Type 35 guides using steel reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.
  - k. Steel Slides: Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 100 mm (4 inches) and larger with medium 15.5 degrees C or greater, a Type 39 saddle may be welded to the pipe and freely rest on a steel plate. On piping under 100 mm (4 inches), a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.
  - l. Insulated Pipe: Insulation on horizontal pipe shall be continuous through hangers for hot and cold piping. Other requirements on insulated pipe are specified in Section 15250 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

### 3.1.3 Anchors

Anchors shall be provided wherever necessary or indicated to localize expansion or to prevent undue strain on piping. Anchors shall consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Anchor braces shall be installed in the most effective manner to secure the desired results using turnbuckles where required. Supports, anchors, or stays shall not be attached where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline.

### 3.1.4 Pipe Sleeves

Sleeves shall not be installed in structural members except where indicated or approved. Rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective wall, floor, or roof, and shall be cut flush with each surface. Pipes passing through concrete or masonry

wall or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Unless otherwise indicated, sleeves shall provide a minimum of 6 mm all-around clearance between bare pipe and sleeves or between jacket over insulation and sleeves. Sleeves in bearing walls, waterproofing membrane floors, and wet areas shall be steel pipe or cast iron pipe. Sleeves in non-bearing walls, floors, or ceilings may be steel pipe, cast iron pipe, galvanized sheet metal with lock-type longitudinal seam and of the metal thickness indicated, or moisture resistant fiber or plastic. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over insulation and sleeve, in non-fire rated walls, shall be sealed as indicated and specified in Section 07920 JOINT SEALING. Pipes passing through wall waterproofing membrane shall be sleeved as specified above, and a waterproofing clamping flange shall be installed as indicated.

#### 3.1.4.1 Roof and Floor Sleeves

Pipes passing through roof or floor waterproofing membrane shall be installed through a 17-ounce copper sleeve or a 0.8 mm thick aluminum sleeve, each within an integral skirt or flange. Flashing sleeve shall be suitably formed, and skirt or flange shall extend not less than 200 mm from the pipe and shall be set over the roof or floor membrane in a troweled coating of bituminous cement. Unless otherwise shown, the flashing sleeve shall extend up the pipe a minimum of 50 mm above highest floor level or a minimum of 250 mm above the roof. The annular space between the flashing sleeve and the bare pipe or between the flashing sleeve and the metal-jacket-covered insulation shall be sealed as indicated. Pipes up to and including 250 mm in diameter passing through roof or floor waterproofing membrane may be installed through a cast iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Waterproofing membrane shall be clamped into place and sealant shall be placed in the caulking recess. In lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve or conduit and sleeve, a modular mechanical type sealing assembly may be installed. Seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal between the pipe/conduit and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe/conduit and sleeve involved.

#### 3.1.4.2 Fire Seal

Where pipes pass through firewalls, fire partitions, or floors, a fire seal shall be provided as specified in Section 07270 FIRESTOPPING.

#### 3.1.4.3 Escutcheons

Escutcheons shall be provided at finished surfaces where exposed piping, bare or insulated, passes through floors, walls, or ceilings except in boiler, utility, or equipment rooms. Where sleeves project slightly from floors, special deep-type escutcheons shall be used. Escutcheons shall be secured to pipe or pipe covering.



### 3.1.5 Condensate Drain Lines

Water seals shall be provided in the condensate drain from all units except room fan-coil units. The depth of each seal shall be 50 mm plus 0.1 mm for each Pa, of the total static pressure rating of the unit to which the drain is connected. Water seals shall be constructed of 2 tees and an appropriate U-bend with the open end of each tee plugged. Pipe cap or plug cleanouts shall be provided where indicated. Drains indicated to connect to the sanitary waste system shall be connected by an indirect waste fitting. Air conditioner drain lines shall be insulated as specified in Section 15250 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

### 3.1.6 Pipe-Alignment Guides

Pipe-alignment guides shall be provided where indicated for expansion loops, offsets, and bends and as recommended by the manufacturer for expansion joints, not to exceed 1.5 m on each side of each expansion joint, and in lines 100 mm or smaller not more than 600 mm on each side of the joint.

### 3.1.7 Air Vents and Drains

#### 3.1.7.1 Vents

Air vents shall be provided at high points, on water coils, and where indicated to ensure adequate venting of the piping system.

#### 3.1.7.2 Drains

Drains shall be provided at low points and where indicated to ensure complete drainage of the piping. Drains shall be accessible, and shall consist of nipples and caps or plugged tees unless otherwise indicated.

### 3.1.8 Valves

Isolation gate or ball valves shall be installed on each side of each piece of equipment such as pumps, heaters, heating or cooling coils, and other similar items, at the midpoint of all looped mains, and at any other points indicated or required for draining, isolating, or sectionalizing purposes. Isolation valves may be omitted where balancing cocks are installed to provide both balancing and isolation functions. Each valve except check valves shall be identified. Valves in horizontal lines shall be installed with stems horizontal or above.

### 3.1.9 Equipment and Installation

Frames and supports shall be provided for tanks, compressors, pumps, valves, air handling units, fans, coils, dampers, and other similar items requiring supports. Air handling units shall be floor mounted or ceiling hung, as indicated. The method of anchoring and fastening shall be as detailed. Floor-mounted equipment, unless otherwise indicated, shall be set on not less than 150 mm concrete pads or curbs doweled in place. Concrete foundations for circulating pumps shall be heavy enough to minimize the intensity of the vibrations transmitted to the piping and the surrounding structure, as recommended in writing by the pump manufacturer. In lieu of a concrete pad foundation, a concrete pedestal block with isolators placed between the pedestal block and the floor may be provided. The concrete

foundation or concrete pedestal block shall be of a mass not less than three times the weight of the components to be supported. Lines connected to the pump mounted on pedestal blocks shall be provided with flexible connectors. Foundation drawings, bolt-setting information, and foundation bolts shall be furnished prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Concrete for foundations shall be as specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE.

#### 3.1.10 Access Panels

Access panels shall be provided for concealed valves, vents, controls, dampers, and items requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced and maintained or completely removed and replaced. Access panels shall be as specified in Section 05500 MISCELLANEOUS METALS.

#### 3.1.11 Flexible Connectors

Pre-insulated flexible connectors and flexible duct shall be attached to other components in accordance with the latest printed instructions of the manufacturer to ensure a vapor tight joint. Hangers, when required to suspend the connectors, shall be of the type recommended by the connector or duct manufacturer and shall be provided at the intervals recommended.

#### 3.1.12 Sleeved and Framed Openings

Space between the sleeved or framed opening and the duct or the duct insulation shall be packed as specified in Section 07270 FIRESTOPPING for fire rated penetrations. For non-fire rated penetrations, the space shall be packed as specified in Section 07900 JOINT SEALING.

#### 3.1.13 Metal Ductwork

Installation shall be according to SMACNA-06 unless otherwise indicated. Duct supports for sheet metal ductwork shall be according to SMACNA-06, unless otherwise specified. Friction beam clamps indicated in SMACNA-06 shall not be used. Risers on high velocity ducts shall be anchored in the center of the vertical run to allow ends of riser to move due to thermal expansion. Supports on the risers shall allow free vertical movement of the duct. Supports shall be attached only to structural framing members and concrete slabs. Supports shall not be anchored to metal decking unless a means is provided and approved for preventing the anchor from puncturing the metal decking. Where supports are required between structural framing members, suitable intermediate metal framing shall be provided. Where C-clamps are used, retainer clips shall be provided.

#### 3.1.14 Acoustical Duct Lining

Lining shall be applied in cut-to-size pieces attached to the interior of the duct with nonflammable fire resistant adhesive conforming to ASTM C 916, Type I, NFPA 90A, UL 723, and ASTM E 84. Top and bottom pieces shall lap the side pieces and shall be secured with welded pins, adhered clips of metal, nylon, or high impact plastic, and speed washers or welding cup-head pins installed according to SMACNA-06. Welded pins, cup-head pins, or adhered clips shall not distort the duct, burn through, nor mar the finish or the surface of the duct. Pins and washers shall be flush with the

surfaces of the duct liner and all breaks and punctures of the duct liner coating shall be sealed with the nonflammable, fire resistant adhesive. Exposed edges of the liner at the duct ends and at other joints where the lining will be subject to erosion shall be coated with a heavy brush coat of the nonflammable, fire resistant adhesive, to prevent delamination of glass fibers. Duct liner may be applied to flat sheet metal prior to forming duct through the sheet metal brake. Lining at the top and bottom surfaces of the duct shall be additionally secured by welded pins or adhered clips as specified for cut-to-size pieces. Other methods indicated in SMACNA-06 to obtain proper installation of duct liners in sheet metal ducts, including adhesives and fasteners, will be acceptable.

#### 3.1.15 Dust Control

To prevent the accumulation of dust, debris and foreign material during construction, temporary dust control protection shall be provided. The distribution system (supply and return) shall be protected with temporary seal-offs at all inlets and outlets at the end of each day's work. Temporary protection shall remain in place until system is ready for startup.

#### 3.1.16 Insulation

Thickness and application of insulation materials for ductwork, piping, and equipment shall be according to Section 15250 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Outdoor air intake ducts and plenums shall be externally insulated up to the point where the outdoor air reaches the conditioning unit.

#### 3.1.17 Duct Test Holes

Holes with closures or threaded holes with plugs shall be provided in ducts and plenums where necessary for the use of pitot tube in balancing the air system. Extensions, complete with cap or plug, shall be provided where the ducts are insulated.

#### 3.1.18 Power Transmission Components Adjustment

V-belts and sheaves shall be tested for proper alignment and tension prior to operation and after 72 hours of operation at final speed. Belts on drive side shall be uniformly loaded, not bouncing. Alignment of direct driven couplings shall be to within 50 percent of manufacturer's maximum allowable range of misalignment.

### 3.2 FIELD PAINTING AND PIPING IDENTIFICATION

Finish painting of items only primed at the factory or surfaces not specifically noted otherwise and identification for piping are specified in Section 09900 PAINTING, GENERAL.

### 3.3 PIPING HYDROSTATIC TEST

After cleaning, water piping shall be hydrostatically tested at a pressure equal to 150 percent of the total system operating pressure for period of time sufficient to inspect every joint in the system and in no case less than 2 hours. Leaks shall be repaired and piping retested until test is successful. No loss of pressure will be allowed. Leaks shall be repaired

by re-welding or replacing pipe or fittings. Caulking of joints will not be permitted. Concealed and insulated piping shall be tested in place before covering or concealing.

### 3.4 DUCTWORK LEAK TEST

Ductwork leak test shall be performed for the entire air distribution and exhaust system, including fans, coils, filters, etc. Test procedure, apparatus, and report shall conform to SMACNA-10. Ductwork leak test shall be completed with satisfactory results prior to applying insulation to ductwork exterior.

### 3.5 CLEANING AND ADJUSTING

Pipes shall be cleaned free of scale and thoroughly flushed of foreign matter. A temporary bypass shall be provided for water coils to prevent flushing water from passing through coils. Strainers and valves shall be thoroughly cleaned. Prior to testing and balancing, air shall be removed from water systems by operating the air vents. Temporary measures, such as piping the overflow from vents to a collecting vessel shall be taken to avoid water damage during the venting process. Air vents shall be plugged or capped after the system has been vented. Inside of room fan-coil units ducts, plenums, and casing shall be thoroughly cleaned of debris and blown free of small particles of rubbish and dust and then shall be vacuum cleaned before installing outlet faces. Equipment shall be wiped clean, with traces of oil, dust, dirt, or paint spots removed. Temporary filters shall be provided prior to startup of all fans that are operated during construction, and new filters shall be installed after all construction dirt has been removed from the building, and the ducts, plenums, casings, and other items specified have been vacuum cleaned. System shall be maintained in this clean condition until final acceptance. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions.

### 3.6 TESTING, ADJUSTING, AND BALANCING

Testing, adjusting, and balancing shall be as specified in Section 15990 TESTING, ADJUSTING AND BALANCING OF HVAC SYSTEMS. Testing, adjusting, and balancing shall begin only when the air supply and distribution, including controls, has been completed, with the exception of performance tests.

### 3.7 PERFORMANCE TESTS

After testing, adjusting, and balancing has been completed as specified, each system shall be tested as a whole to see that all items perform as integral parts of the system and temperatures and conditions are evenly controlled throughout the building. Corrections and adjustments shall be made as necessary to produce the conditions indicated or specified. Capacity tests and general operating tests shall be conducted by an experienced engineer. Tests shall cover a period of not less than 5 days for each system and shall demonstrate that the entire system is functioning according to the specifications. Coincidental chart recordings shall be made at points indicated on the drawings for the duration of the time period and shall record the temperature at space thermostats or space sensors, the

humidity at space humidistats or space sensors and the ambient temperature and humidity in a shaded and weather protected area.

### 3.8 FIELD TRAINING

The Contractor shall conduct a training course for operating and maintenance personnel as designated by the Contracting Officer. Training shall be provided for a period of 8 hours of normal working time and shall start after the system is functionally complete but prior to the performance tests. The field instruction shall cover all of the items contained in the approved Operating and Maintenance Instructions.

## SECTION 15950

## HEATING, VENTILATING AND AIR CONDITIONING (HVAC) CONTROL SYSTEMS

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)

AMCA 500 (1989) Test Methods for Louvers, Dampers and Shutters

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 269 (1994a) Seamless and Welded Austenitic Stainless Steel Tubing for General Service

ASTM B 88 (1996) Seamless Copper Water Tube

ASTM D 635 (1991) Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position

ASTM D 1693 (1994) Environmental Stress-Cracking of Ethylene Plastics

## AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B40.1 (1991) Gauges - Pressure Indicating Dial Type - Elastic Element

## CODE OF FEDERAL REGULATIONS (CFR)

47 CFR 15 Radio Frequency Devices

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (1991) Enclosures for Electrical Equipment (1000 Volts Maximum)

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A (1993) Installation of Air Conditioning and Ventilating Systems

## UNDERWRITERS LABORATORIES (UL)

UL 94 (1996) Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

UL 268A (1993; Rev Apr 1994) Smoke Detectors for Duct Application

UL 508 (1993) Industrial Control Equipment

UL 916 (1994; Rev thru May 1996) Energy Management Equipment

## 1.2 GENERAL REQUIREMENTS

### 1.2.1 Verification of Dimensions

The Contractor shall become familiar with all details of the work, shall verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

### 1.2.2 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall investigate the mechanical, electrical, and finish conditions that could affect the work to be performed, shall arrange such work accordingly, and shall furnish all work necessary to meet such conditions.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

### SD-01 Data

Equipment Compliance Booklet; GA.

An HVAC control system equipment compliance booklet (ECB) in indexed booklet form with numbered tabs separating the information on each device. It shall consist of, but not be limited to, data sheets and catalog cuts which document compliance of all devices and components with the specifications. The ECB shall be indexed in alphabetical order by the unique identifiers. Devices and components which do not have unique identifiers shall follow the devices and components with unique identifiers and shall be indexed in alphabetical order according to their functional name. The ECB shall include a bill of materials for each HVAC control system. The bill of materials shall function as the table of contents for the ECB and shall include the device's unique identifier, device function, manufacturer, model/part/catalog number used for ordering, and tab number where the device information is located in the ECB.

### SD-04 Drawings

HVAC Control System; GA.

Drawings on A1 841 by 594 mm sheets in the form and arrangement shown. The drawings shall use the same abbreviations, symbols, nomenclature and device identifiers shown. Each control-system element on a drawing shall have a unique identifier as shown. All HVAC control system drawings shall be delivered together as a complete submittal. Drawings shall be submitted for each HVAC system.

- a. HVAC control system drawings shall include the following:

Sheet One: Drawing index, HVAC control system legend.

Sheet Two: Valve schedule, damper schedule.

Sheet Three: Compressed air station schematic.

Sheet Four: HVAC control system schematic and equipment schedule.

Sheet Five: HVAC control system sequence of operation and ladder diagram.

Sheet Six: HVAC control panel arrangement, control panel cross-section, and control panel inner door layout.

Sheet Seven: HVAC control panel back-panel layout.

Sheet Eight: Control loop wiring diagrams.

Sheet Nine: Motor starter and relay wiring diagram.

Note: Repeat sheets four through nine for each AHU system.

- b. An HVAC control system drawing index showing the name and number of the building, military site, State or other similar designation, and Country. The drawing index shall list all HVAC control system drawings, including the drawing number, sheet number, drawing title, and computer filename when used.
- c. An HVAC control system legend showing generic symbols and the name of devices shown on the HVAC control system drawings.
- d. A valve schedule showing each valve's unique identifier, size, flow coefficient (Cv), pressure drop at specified flow rate, spring range, positive positioner range, actuator size, close-off pressure data, dimensions, and access and clearance requirements data.
- e. A damper schedule showing each damper and actuator's identifier, nominal and actual sizes, orientation of axis and frame, direction of blade rotation, spring ranges, operation rate, positive positioner ranges, locations of actuators and damper end switches, arrangement of sections in multi-section dampers, and methods of connecting dampers, actuators, and linkages. The damper schedule shall include the maximum leakage rate at the operating static-pressure differential. The damper schedule shall contain actuator selection data supported by calculations of the torque required to move and seal the dampers, access and clearance requirements.
- f. A compressed-air station schematic diagram showing all equipment, including: compressor with motor horsepower and voltage; starter; isolators; manual bypasses; tubing sizes; drain piping and drain traps; reducing valves; dryer; and data on manufacturer's names and model numbers, mounting, access, and clearance requirements. Air compressor and air dryer data shall include calculations of the air consumption of current-to-pneumatic transducers and any other control system devices to be connected to the compressed air



station, and the compressed air supply dewpoint temperature at 140 kPa (gauge).

- g. An HVAC control system equipment schedule showing the control loop, device unique identifier, device function, setpoint, input range, and additional important parameters (i.e. output range).
- h. An HVAC control system sequence of operation.
- i. An HVAC control system ladder diagram showing all relays, contacts, pilot lights, switches, fuses and starters connected to the control system.
- j. HVAC control panel arrangement drawings showing both side and front views of the panel. The drawing shall show panel and mounting dimensions.
- k. HVAC control panel cross-section drawings showing mounting rails and standoffs for devices.
- l. HVAC control panel inner door layout drawings showing both front and rear views of the inner door. The drawings shall show device locations, labels, nameplate legends, and fabrication details.
- m. HVAC control panel back-panel layout drawings showing device locations, labels, nameplate legends, terminal block layout, fabrication details, and enclosure operating temperature-rise calculations.
- n. HVAC control system wiring diagrams showing functional wiring diagrams of the interconnection of conductors and cables to HVAC control panel terminal blocks and to the identified terminals of devices, starters and package equipment. The wiring diagrams shall show all necessary jumpers and ground connections. The wiring diagrams shall show the labels of all conductors. Sources of power required for HVAC control systems and for packaged-equipment control systems shall be identified back to the panel-board circuit breaker number, HVAC system control panel, magnetic starter, or packaged equipment control circuit. Each power supply and transformer not integral to a controller, starter, or packaged equipment shall be shown. The connected volt-ampere load and the power supply volt-ampere rating shall be shown.

#### SD-08 Statements

##### Commissioning Procedures; GA.

- a. Six copies of the HVAC control system commissioning procedures, in indexed booklet form, 60 days prior to the scheduled start of commissioning. Commissioning procedures shall be provided for each HVAC control system, and for each type of terminal-unit control system. The commissioning procedures shall reflect the format and language of this specification, and refer to devices by their unique identifiers as shown. The commissioning procedures shall be specific for each HVAC system, and shall give detailed step-by-step procedures for commissioning of the system.

- b. Commissioning procedures documenting detailed, product-specific set-up procedures, configuration procedures, adjustment procedures, and calibration procedures for each device. Where the detailed product-specific commissioning procedures are included in manufacturer supplied manuals, reference may be made in the HVAC control system commissioning procedures to the manuals.
- c. Commissioning procedures documenting controller configuration checksheets for each controller listing all configuration parameters, dip switch and jumper settings, and initial recommended P, I and D values. The configuration parameters shall be listed in the order in which they appear during the configuration process. Each configuration parameter shall be noted as being: set per specs with no field adjustment required, set per specs but field adjustable, or not applicable.
- d. Commissioning procedures showing a time clock configuration checksheet listing all parameters, and switch settings. The parameters shall be listed in the order which they appear during the setup process.
- e. An HVAC control system commissioning procedures equipment list that lists the equipment to be used to accomplish commissioning. The list shall include manufacturer name, model number, equipment function, the date of the latest calibration, and the results of the latest calibration.

#### Performance Verification Test Procedures; GA.

Six copies of the HVAC control system performance verification test procedures, in indexed booklet form, 60 days before the Contractor's scheduled test dates. The performance verification test procedures shall refer to the devices by their unique identifiers as shown, shall explain, step-by-step, the actions and expected results that will demonstrate that the HVAC control system performs in accordance with the sequences of operation. An HVAC control system performance verification test equipment list shall be included that lists the equipment to be used during performance verification testing. The list shall include manufacturer name, model number, equipment function, the date of the latest calibration, and the results of the latest calibration.

#### Training Course Materials; GA.

Six copies of HVAC control system training course material 30 days prior to the scheduled start of the training course. The training course material shall include the operation manual, maintenance and repair manual, and paper copies of overheads used in the course. An HVAC control system training course, in outline form, with a proposed time schedule. Approval of the planned training schedule shall be obtained from the Government at least 60 days prior to the start of the training.

#### SD-09 Reports

##### Commissioning Report; GA.

Six copies of the HVAC control system commissioning report, in indexed booklet form, within 30 days after completion of the system commissioning.

The commissioning report shall include data collected during the HVAC control system commissioning and shall follow the format of the commissioning procedures. The commissioning report shall include all controller and time clock checksheets with final values listed for all parameters, setpoints, P, I, D setting constants, calibration data for all devices, and results of adjustments.

Performance Verification Test Report; GA.

Six copies of the HVAC control system performance verification test report, in indexed booklet form, within 30 days after completion of the test. The HVAC control system performance verification test report shall include data collected during the HVAC control system performance verification test. The original copies of data gathered during the performance verification test shall be turned over to the Government after Government approval of the test results.

#### SD-13 Certificates

ASME Air-Storage Tank Certificate; FIO.

An ASME Air-Storage Tank Certificate for each storage tank.

#### SD-18 Records

Service Organizations; FIO.

Six copies of a list of service organizations qualified to service the HVAC control system. The list shall include the service organization name, address, technical point of contact and telephone number, and contractual point of contact and telephone number.

#### SD-19 Operation and Maintenance Manuals

Operation Manual; GA.

Maintenance and Repair Manual; FIO.

Six copies of the HVAC control system operation manual and HVAC control system maintenance and repair manual for each HVAC control system 30 days before the date scheduled for the training course.

### 1.4 DELIVERY AND STORAGE

Products shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, and other contaminants, within the storage-condition limits published by the equipment manufacturer. Dampers shall be stored so that seal integrity, blade alignment and frame alignment are maintained.

### 1.5 OPERATION MANUAL

An HVAC control system operation manual for each HVAC control system, in indexed booklet form, shall be provided. The operation manual shall include the HVAC control system sequence of operation, and procedures for the HVAC system start-up, operation and shut-down. The operation manual shall include as-built HVAC control system detail drawings. The operation manual

shall include the as-built controller configuration checksheets, the as-built time clock configuration checksheet, the HVAC control system front panel description, the procedures for changing HVAC system controller setpoints, the procedures for gaining manual control of processes, the time clock manufacturer's manual control of processes, the time clock manufacturer's operation manual, and the controller manufacturer's operation manual.

- a. The HVAC control system front panel description shall explain the meaning and use of the lights, switches, gauges, and controller displays located in the front panel. Each light, switch, gauge, and display described shall be numbered and referenced to a drawing of the front panel.
- b. The procedures for changing HVAC system controller setpoints shall describe the step-by-step procedures required to change: the process variable setpoints of controllers, the alarm setpoints of controllers, the controller bias settings, and controller setpoint reset schedules.
- c. The procedures for gaining manual control of processes shall describe step-by-step procedures required to gain manual control of devices and manually adjust their positions.

#### 1.6 MAINTENANCE AND REPAIR MANUAL

An HVAC control system maintenance and repair manual for each HVAC control system, in indexed booklet form in hardback binders, shall be provided. The maintenance and repair manual shall include the routine maintenance checklist, a recommended repair methods list, a list of recommended maintenance and repair tools, the qualified service organization list, the as-built commissioning procedures and report, the as-built performance verification test procedures and report, and the as-built equipment data booklet (EDB).

- a. The routine maintenance checklist shall be arranged in a columnar format. The first column shall list all devices listed in the equipment compliance booklet (ECB), the second column shall state the maintenance activity or state no maintenance required, the third column shall state the frequency of the maintenance activity, and the fourth column for additional comments or reference.
- b. The recommended repair methods list shall be arranged in a columnar format and shall list all devices in the equipment compliance booklet (ECB) and state the guidance on recommended repair methods, either field repair, factory repair, or whole-item replacement.
- c. The as-built equipment data booklet (EDB) shall include the equipment compliance booklet (ECB) and all manufacturer supplied user manuals and information.
- d. If the operation manual and the maintenance and repair manual are provided in a common volume, they shall be clearly differentiated and separately indexed.

## 2 PRODUCTS

### 2.1 MATERIAL AND EQUIPMENT

Material and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such products which are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 years experience must be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. The equipment items shall be supported by a service organization. The Contractor shall submit a certified list of qualified permanent service organizations and qualifications. These service organizations shall be reasonably convenient to the equipment on a regular and emergency basis during the warranty period.

### 2.2 GENERAL EQUIPMENT REQUIREMENTS

#### 2.2.1 General Control Systems Requirements

Controls for systems shown to use the single loop controller type controls systems shall be provided as shown and specified herein for single loop controller systems or at the option of the contractor, the control systems shown to use single loop controllers may be provide using Williams Electric Company (WEC) Direct Digital Control (DDC) controllers, panels and interfaces. If the WEC DDC controls option is selected, As-built drawings and submittals shall include all of the information required for the single loop control type panels, including ladder diagrams, equipment tables, setpoints, etc. as currently shown for the Single Loop controller systems on the project HVAC controls drawings.

#### 2.2.2 Electrical and Electronic Devices

All electrical, electronic, and electro-pneumatic devices not located within an HVAC control panel shall have a NEMA Type 1 enclosure in accordance with NEMA 250 unless otherwise shown.

#### 2.2.3 Standard Signals

The output of all analog transmitters and the analog input and output of all single-loop controllers and function modules shall be 4-to-20 mA<sub>dc</sub> signals. The signal shall originate from current-source devices and shall be received by current-sink devices.

#### 2.2.4 Ambient Temperature Limits

Ambient Temperature Actuators and positive positioners, and transmitters shall operate within temperature limit ratings of 5 to 60 degrees C. All panel-mounted instruments shall operate within limit ratings of 2 to 50 degrees C and 10 percent to 95 percent relative humidity, noncondensing.

All devices installed outdoors shall operate within limit ratings of minus 40 to plus 65 degrees C.

#### 2.2.5 Nameplates, Lens Caps, and Tag Nameplates

Nameplates, lens caps, and lens caps bearing legends as shown and tags bearing device-unique identifiers as shown shall have engraved or stamped characters. A plastic or metal tag shall be mechanically attached directly to each device or attached by a metal chain or wire. Each air flow measurement station shall have a tag showing flow rate range for signal output range, duct size, and identifier as shown.

### 2.3 MATERIALS

#### 2.3.1 Tubing

##### 2.3.1.1 Copper

Copper tubing shall conform to ASTM B 88 and shall have sweat fittings and valves.

##### 2.3.1.2 Plastic

Plastic tubing shall have barbed fittings and valves. Plastic tubing shall have the burning characteristics of linear low-density polyethylene tubing, shall be self-extinguishing when tested in accordance with ASTM D 635, shall have UL 94 V-2 flammability classification, and shall withstand stress cracking when tested in accordance with ASTM D 1693. Plastic-tubing bundles shall be provided with Mylar barrier and flame-retardant polyethylene jacket.

##### 2.3.1.3 Stainless Steel

Stainless steel tubing shall conform to ASTM A 269, and shall have stainless steel compression fittings.

#### 2.3.2 Wiring

##### 2.3.2.1 Terminal Blocks

Terminal blocks shall be insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, shall be suitable for rail mounting, and shall have end plates and partition plates for separation or shall have enclosed sides.

##### 2.3.2.2 Control Wiring for 24-Volt Circuits

Control wiring for 24-volt circuits shall be 18 AWG minimum, stranded copper and shall be rated for 300-volt service.

##### 2.3.2.3 Wiring for 120-Volt Circuits

Wiring for 120-volt circuits shall be 18 AWG minimum, stranded copper and shall be rated for 600-volt service.

#### 2.3.2.4 Analog Signal Wiring Circuits

Analog signal wiring circuits within control panels shall not be less than 20 AWG and shall be rated for 300-volt service.

#### 2.3.2.5 Instrumentation Cable

Instrumentation cable shall be 18 AWG, stranded copper, single or multiple-twisted, minimum 51 mm lay of twist, 100 percent shielded pairs, and shall have a 300-volt insulation. Each pair shall have a 20 AWG tinned-copper drain wire and individual overall pair insulation. Cables shall have an overall aluminum-polyester or tinned-copper cable-shield tape, overall 20 AWG tinned-copper cable drain wire, and overall cable insulation.

#### 2.3.2.6 Non-conducting Wiring Duct

Non-conducting wiring duct in control panels shall have wiring duct in control panels shall have slotted sides, snap-on duct covers, have slotted sides, snap-on duct covers, fittings for connecting ducts, mounting clips for securing ducts, and wire-retaining clips.

#### 2.3.2.7 Transformers

Step-down transformers shall be utilized where control equipment operates at lower than line circuit voltage. Transformers, other than transformers in bridge circuits, shall have primaries wound for the voltage available and secondaries wound for the correct control circuit voltage. Transformers shall be sized so that the connected load is 80 percent of the rated capacity or less. Transformers shall conform to UL 508.

### 2.4 ACTUATORS

Actuators shall be pneumatic, electric or electronic as shown and shall be provided with mounting and connecting hardware. Actuators shall fail to their spring-return positions on signal or power failure. The actuator stroke shall be limited in the direction of power stroke by an adjustable stop. Actuators shall have a visible position indicator. Actuators shall smoothly open or close the devices to which they are applied and shall have a full stroke response time of 60 seconds or less. Electric or electronic actuators operating in series shall have an auxiliary actuator driver. Pneumatic actuators shall be rated for 172 kPa operating pressure except for high-pressure cylinder-type actuators. Electric actuators shall have an oil-immersed gear train. Electric actuators used in a sequencing application shall have zero and span adjustments.

#### 2.4.1 Valve Actuators

Valve actuators shall be selected to provide a minimum of 125 percent of the motive power necessary to operate the valve over its full range of operation.

#### 2.4.2 Positive Positioners

Positive positioners are required for pneumatic actuators. Each positive positioner shall be a pneumatic relay with a mechanical feedback mechanism and an adjustable operating range and starting point.

## 2.5 AUTOMATIC CONTROL VALVES

### 2.5.1 Valve Assembly

Valves shall have stainless-steel stems and stuffing boxes with extended necks to clear the piping insulation. Unless otherwise stated, valves shall have globe style bodies. Valve bodies shall be designed for not less than 862 kPa working pressure or 150 percent of the system operating pressure, whichever is greater. Valve leakage rating shall be 0.01 percent of rated Cv.

### 2.5.2 Two-Way Valves

Two-way modulating valves shall have equal-percentage characteristics.

### 2.5.3 Three-Way Valves

Three-way valves shall provide linear flow control with constant total flow throughout full plug travel.

### 2.5.4 Terminal-Unit-Coil Valves

Control valves with either flare-type or solder-type ends shall be provided for duct or terminal-unit coils. Flare nuts shall be furnished for each flare-type end valve.

### 2.5.5 Valves for Chilled Water (Glycol/Water Mixture) Service

Bodies for valves 40 mm and smaller shall be brass or bronze, with threaded or union ends. Bodies for valves from 50 to 80 mm inclusive shall be of brass, bronze or iron. Bodies for 50 mm valves shall have threaded ends. Valve Cv shall be chosen for full flow pressure drops of 3.0 meters or slightly more of water for fan-coil units and air handling unit coils. Valve Cv shall be chosen for full flow pressure drops of 3.0 meters or less of water for supply water temperature control of chilled water. Bodies for valves from 65 to 80 mm shall have flanged-end connections. Internal valve trim shall be brass or bronze except that valve stems may be type 316 stainless steel. Valves 100 mm and larger shall be butterfly valves.

### 2.5.6 Valves for Hot-Water Service

Valves for hot-water service below 121 degrees C shall be as follows: Bodies for valves 40 mm and smaller shall be brass or bronze, with threaded or union ends. Bodies for 50 mm valves shall have threaded ends. Bodies for valves from 50 to 80 mm inclusive shall be of brass, bronze, or iron. Bodies for valves 100 mm and larger shall be iron. Bodies for valves 65 mm and larger shall be provided with flanged-end connections. Valve Cv shall be chosen for full flow pressure drops of 3.0 meters or slightly more of water for fan-coil units, unit heaters, air handling unit coils. Valve Cv shall be chosen for full flow pressure drops of 3.0 meters or less of water for supply water temperature control of heating hot water. Internal trim (including seats, seat rings, modulating plugs, and springs) of valves controlling water hotter than 99 degrees C shall be Type 316 stainless steel. Internal trim for valves controlling water 99 degrees C or less shall be brass or bronze. Nonmetallic parts of hot-water control valves shall be suitable for a minimum continuous operating temperature of 121 degrees C or 10 degrees C above the system design temperature, whichever is



higher. Valves 100 mm is higher. Valves 100 mm and larger shall be butterfly valves.

## 2.6 DAMPERS

### 2.6.1 Damper Assembly

A single damper section shall have blades no longer than 1.2 m and shall be no higher than 1.8 m. Maximum damper blade width shall be 203 mm. Larger sizes shall be made from a combination of sections. Dampers shall be steel, or other materials where shown. Flat blades shall be made rigid by folding the edges. All blade-operating linkages shall be within the frame so that blade-connecting devices within the same damper section will not be located directly in the air stream. Damper axles shall be 13 mm (minimum) plated steel rods supported in the damper frame by stainless steel or bronze bearings. Blades mounted vertically shall be supported by thrust bearings. Pressure drop through dampers shall not exceed 10 Pa at 5 m/s in the wide-open position. Frames shall not be less than 50 mm in width. Dampers shall be tested in accordance with AMCA 500.

#### 2.6.1.1 Operating Links

Operating links external to dampers (such as crankarms, connecting rods, and line shafting for transmitting motion from damper actuators to dampers) shall withstand a load equal to at least twice the maximum required damper-operating force. Rod lengths shall be adjustable. Links shall be brass, bronze, zinc-coated steel, or stainless steel. Working parts of joints and clevises shall be brass, bronze, or stainless steel. Adjustments of crankarms shall control the open and closed positions of dampers.

#### 2.6.1.2 Damper Types

Dampers shall be the parallel blade type.

### 2.6.2 Outside-Air, Return-Air, and Relief-Air Dampers

The dampers shall be provided where shown. Blades shall have interlocking edges and shall be provided with compressible seals at points of contact. The channel frames of the dampers shall be provided with jamb seals to minimize air leakage. Dampers shall not leak in excess of 102 L/s per square meter at 1,000 Pa (gauge) static pressure when closed. Seals shall be suitable for an operating temperature range of minus 40 to plus 93 degrees C. Dampers shall be rated at not less than 10 m/s air velocity.

### 2.6.3 Mechanical and Electrical Space Ventilation Dampers

The dampers shall be provided where shown. Blades shall have interlocking edges and shall be provided with compressible seals at points of contact. The channel frames of the dampers shall be provided with jamb seals to minimize air leakage. Dampers shall not leak in excess of 102 L/s per square meter at 1,000 Pa (gauge) static pressure when closed. Seals shall be suitable for an operating temperature range of minus 40 to plus 93 degrees C. Dampers shall be rated at not less than 10 m/s air velocity.

#### 2.6.4 Damper End Switches

Each end switch shall be a hermetically-sealed switch with a trip lever and over-travel mechanism. The switch enclosure shall be suitable for mounting on the duct exterior and shall permit setting the position of the trip lever that actuates the switch. The trip lever shall be aligned with the damper blade.

#### 2.7 DUCT SMOKE DETECTORS

Duct smoke detectors shall conform to the requirements of UL 268A. Duct smoke detectors shall have perforated sampling tubes extended into the air duct. Detector circuitry shall be mounted in a metallic enclosure exterior to the duct. Detectors shall have manual reset. Detectors shall be rated for air velocities that include air flows between 2.5 and 20 m/s. Detectors shall be powered from the HVAC control panel. Detectors shall have two sets of normally open alarm contacts and two sets of normally closed alarm contacts. Detectors shall be connected to the building fire alarm panel for alarm initiation. A remote annunciation lamp and accessible remote reset switch shall be provided for duct detectors that are mounted eight feet or more above the finished floor and for detectors that are not readily visible. Remote lamps and switches as well as each affected fan unit shall be properly identified in etched rigid plastic placards.

#### 2.8 INSTRUMENTATION

##### 2.8.1 Measurements

Transmitters shall be factory calibrated to provide an output of 4 to 20 mAdc over the indicated ranges:

- a. Conditioned space temperature, from 10 to 30 degrees C.
- b. Duct temperature, from 5 to 60 degrees C except that return-air temperature for economizer operation shall be minus 35 to plus 55 degrees C.
- c. Chilled-water temperature, from minus 1 to plus 38 degrees C.
- d. Dual-temperature water, from minus 1 to plus 116 degrees C.
- e. Heating hot-water temperature, from 38 to 121 degrees C.
- f. Outside-air temperature, from minus 35 to plus 55 degrees C.

##### 2.8.2 Temperature Instruments

###### 2.8.2.1 Resistance Temperature Detectors (RTD)

Temperature sensors shall be 100 ohms 3- or 4-wire RTD. Each RTD shall be platinum with a tolerance of plus or minus 0.1 percent at 0 degrees C, and shall be encapsulated in epoxy, series 300 stainless steel, anodized aluminum, or copper. Each RTD shall be furnished with an RTD transmitter as specified, integrally-mounted unless otherwise shown.

#### 2.8.2.2 Continuous-Averaging RTD

Continuous-averaging RTDs shall have a tolerance of plus or minus 0.5 degree C at the reference temperature, and shall be of sufficient length to ensure that the resistance represents an average over the cross-section in which it is installed. The sensing element shall have a bendable copper sheath. Each averaging RTD shall be furnished with an RTD transmitter as specified, to match the resistance range of the averaging RTD.

#### 2.8.2.3 RTD Transmitter

The RTD transmitter shall accept a 3-wire 100 ohm RTD input. The transmitter shall be a 2-wire, loop-powered device. The transmitter shall produce a linear 4-to-20 mA<sub>dc</sub> output corresponding to the required temperature measurement. The output error shall not exceed 0.1 percent of the calibrated span. The transmitter shall include offset and span adjustments.

#### 2.8.3 Differential Pressure Instruments

The instrument shall be a pressure transmitter with an integral sensing element. The instrument over pressure rating shall be 300 percent of the operating pressure. The sensor/transmitter assembly accuracy shall be plus or minus 2 percent of full scale. The transmitter shall be a 2-wire, loop-powered device. The transmitter shall produce a linear 4-to-20 mA<sub>dc</sub> output corresponding to the required pressure measurement. Each transmitter shall have offset and span adjustments.

#### 2.8.4 Thermowells

Thermowells shall be Series 300 stainless steel with threaded brass plug and chain, 50 mm lagging neck and extension-type well, and inside diameter and insertion length as required for the application.

#### 2.8.5 Sunshields

Sunshields for outside-air temperature sensing elements shall prevent the sun from directly striking temperature sensing elements. The sunshields shall be provided with adequate ventilation so that the sensing element responds to the ambient temperature of the surroundings. The top of each sunshield shall have a separate galvanized-metal rain shield projecting over the face of the sunshield. The sunshields shall be painted white or shall be unpainted aluminum.

### 2.9 THERMOSTATS

Thermostat ranges shall be selected so that the setpoint is adjustable without tools between plus or minus 5 degrees C of the setpoint shown, except for fan coil thermostat which shall be as described below. Thermostats shall be electronic or electric.

#### 2.9.1 Non-modulating Room Thermostats

Contacts shall be single-pole double-throw (SPDT), hermetically sealed, and wired to identified terminals. Maximum differential shall be 2.75 degrees C. Room thermostats shall be enclosed with separate locking covers

(guards). Thermostats shall have manual switches as required by the application and as shown.

#### 2.9.2 Low-Temperature-Protection (Freezestat) Thermostats

Low-temperature-protection thermostats shall be, low-temperature safety thermostats, with NO and NC contacts and manual reset, with an element length of 6 meters, which shall respond to the coldest 460 mm segment.

#### 2.9.3 Fan-Coil Unit Room Thermostats

Fan-coil unit room thermostats in personnel living spaces shall be of the low-voltage electric and electronic type with locking covers. Electrical rating shall not exceed 2.5 amperes at 30 volts ac. Housing shall be corrosion resistant metal or molded plastic. Transformer and fan relay shall be provided for the proper operation of each thermostatic control system as necessary to suit the design of the control system using the thermostats specified below. Either separate heating thermostats and separate cooling thermostats or dual element heating-cooling thermostats may be provided. Motor speed switches shall be provided for 3-speed fan control. The thermostat shall have a sub-base for occupant selection (changeover) of heating or cooling; the switch shall be labeled and provide selection as follows, heat-off-cool.

##### 2.9.3.1 Heating Thermostats

Fan-coil heating thermostats shall be provided with fixed heat anticipation and shall have a single-pole, single-throw (SPST) switch hermetically sealed and actuated by a bimetallic or bellows type element. Thermostats shall be provided with external temperature setting devices with a factory set maximum of 22 degrees C. Heating thermostats shall have an adjustable range of at least 7 degrees below 22 degrees C.

##### 2.9.3.2 Cooling Thermostats

Fan-coil cooling thermostats shall be provided with fixed cooling anticipation heater and shall have a single-pole, single-throw (SPST) switch hermetically sealed and actuated by a bimetallic or bellows type element. Thermostats shall be provided with external temperature setting devices with a factory set minimum of 23.8 degrees C. Cooling thermostats shall have an adjustable range of at least 4 degrees C above 23.8 degrees C.

##### 2.9.3.3 Dual Element Thermostats

Fan-coil unit combination heating-cooling thermostats shall be provided with separate temperature sensing elements for each system, and shall have a single-pole, single-throw (SPST) switch hermetically sealed and actuated by a bimetallic or bellows type element. Each element shall operate switches to provide single stage control for heating and cooling. Heating and cooling circuits shall be electrically isolated from each other. Scales and ranges shall be as specified for individual thermostats. A limited range heating-cooling dead band thermostat shall control cooling when temperature is above the upper setpoint and heating when temperature is below the lower setpoint and shall have a dead band, with no heating or cooling, when temperature is between the setpoints. Setpoint adjustment shall be concealed. Setpoints, ranges and adjustments shall be as above for fan-coil unit cooling and heating thermostats.

## 2.10 PRESSURE SWITCHES AND SOLENOID VALVES

### 2.10.1 Pressure Switches

Each switch shall have an adjustable setpoint with visible setpoint scale. Range shall be as shown. Differential adjustment shall span 20 to 40 percent of the range of the device.

### 2.10.2 Differential-Pressure Switches

Each switch shall be an adjustable diaphragm-operated device with two SPDT contacts, with taps for sensing lines to be connected to duct pressure fittings designed to sense air pressure. These fittings shall be of the angled-tip type with tips pointing into the air stream. The setpoint shall not be in the upper or lower quarters of the range and the range shall not be more than three times the setpoint. Differential shall be a maximum of 35 Pa at the low end of the range and 85 Pa at the high end of the range.

### 2.10.3 Pneumatic Electric (PE) Switches

Each switch shall have an adjustable setpoint range of 20 to 140 kPa with a switching differential adjustable from 15 to 35 kPa. The switch action shall be SPDT.

### 2.10.4 Solenoid-Operated Pneumatic (EP) Valves

Each valve shall have three-port operation: common, normally open, and normally closed. Each valve shall have an outer cast-aluminum body and internal parts of brass, bronze, or stainless steel. The air connection shall be a 10 mm NPT threaded connection. Valves shall be rated for 345 kPa when used in a control system that operates at 172 kPa or less, or 1035 kPa when used in a control system that operates in the range of 172 to 690 kPa.

## 2.11 INDICATING DEVICES

### 2.11.1 Thermometers

#### 2.11.1.1 Piping System Thermometers

Piping system thermometers shall have brass, malleable iron or aluminum alloy case and frame, clear protective face, permanently stabilized glass tube with indicating-fluid column, white face, black numbers, and a 230 mm scale. Thermometers for piping systems shall have rigid stems with straight, angular, or inclined pattern.

#### 2.11.1.2 Piping System Thermometer Stems

Thermometer stems shall have expansion heads as required to prevent breakage at extreme temperatures. On rigid-stem thermometers, the space between bulb and stem shall be filled with a heat-transfer medium.

#### 2.11.1.3 Non-Averaging Air-Duct Thermometers

Air-duct thermometers shall have perforated stem guards and 45-degree adjustable duct flanges with locking mechanism.

#### 2.11.1.4 Averaging Air-Duct Thermometers

Averaging thermometers shall have a 90 mm (nominal) dial, with black legend on white background, and pointer traveling through a 270-degree arc.

#### 2.11.1.5 Accuracy

Thermometers shall have an accuracy of plus or minus 1 percent of scale range. Thermometers shall have a range suitable for the application.

#### 2.11.2 Pressure Gauges

Gauges shall be 50 mm (nominal) size, back connected, suitable for field or panel mounting as required, shall have black legend on white background, and shall have a pointer traveling through a 270-degree arc. Accuracy shall be plus or minus 3 percent of scale range. Gauges shall meet requirements of ASME B40.1.

##### 2.11.2.1 Pneumatic Actuator Gauges

Field mounted gauges for indicating signal input to pneumatic actuators shall have a scale of 0 to 200 kPa with 10 kPa graduations.

##### 2.11.2.2 Air Storage Tank, Filter, and Dryer Gauges

Gauges for air storage tanks, or for use before and after dryers or dirt and oil filters, shall have a scale of 0 to 1100 kPa with 20 kPa graduations.

##### 2.11.2.3 Hydronic-System Gauges

Gauges for hydronic-system applications shall have ranges and graduations as specified and as shown.

##### 2.11.2.4 Control Panel Pressure Gauges

Panel mounted air pressure gauges shall have a scale of 0 to 200 kPa with 10 kPa graduations.

#### 2.11.3 Low Differential Pressure Gauges

Gauges for low differential-pressure measurements shall be a minimum of 90 mm (nominal) size with two sets of pressure taps, and shall have a diaphragm-actuated pointer, white dial with black figures, and pointer zero adjustment. Gauges shall have ranges and graduations as shown. Accuracy shall be plus or minus 2 percent of scale range.

#### 2.12 SINGLE-LOOP CONTROLLERS

##### 2.12.1 Controller Features

The controller shall be a microprocessor-based single-loop device that does not require Contractor generated software. The controller shall be mountable in a panel cutout measuring 92 by 92 mm. The controller shall have field scalable process variable, a remote setpoint analog input and an analog output with adjustable high and low end limits and proportional control manual reset adjustment. The analog output shall result from proportional, integral and derivative (PID) control. The analog output

shall be configurable as direct acting and reverse acting. The controller shall have keyboard, display, auto/manual selection for control of its analog output, remote setpoint adjustment/local setpoint adjustment selection with adjustable high-end and low-end limits, ratio and bias adjustments on remote setpoint input, operator-initiated self-tune/manual-tune selection, anti-reset wind-up feature, and 2 independent SPDT contact-closure outputs (PV alarm and deviation alarm). The controller shall be configurable to power-up in automatic with local setpoint control and in automatic with remote setpoint control. The range of hysteresis adjustment shall be not smaller than from 1 percent to 5 percent of process variable input span. The controller shall power the analog output loop to 20 milliamperes when connected to a load of 600 ohms. The controller shall be capable of retransmitting the process variable to 20 milliamperes when connected to 600 ohms. The controller shall have 5-year battery backup to store operating parameters or shall have nonvolatile memory.

#### 2.12.2 Parameter Input and Display

Control parameters shall be entered and displayed directly, in the correct engineering units, through a series of keystrokes on a front-panel display with a 3-1/2 digit, 7-segment display, with decimal point and polarity indication. The use of this display shall allow manual interrogation of setpoint, mode constants, and values of the process variable and output.

#### 2.12.3 Controller Electrical Requirements

Each controller shall be powered by 120 volts ac. Power consumption shall not be greater than 25 watts. Each controller shall provide electrical noise isolation between the ac power line and the process variable input, remote setpoint input, and output signals and of not less than 100 db at 60 Hz common-mode rejection ratio, and not less than 60 db at 60 Hz normal-mode rejection ratio.

#### 2.12.4 Controller Accuracy

The controller shall have an accuracy of plus or minus 0.30 percent of input span, plus or minus 1 digit.

#### 2.12.5 Self-Tuning

The controller self-tuning operation shall apply proportional, integral, and derivative modes of control and shall modify the mode constants as required. Self-tuning shall only be in operation when selected from the front panel.

#### 2.12.6 Manual-Tuning

The controller manual-tuning operation shall provide proportional, integral, and derivative control modes, or any combination thereof, by means of individual mode constant adjustments. These adjustments shall be set for the appropriate value if a particular control mode action is desired, or to zero if that particular mode is not desired. The proportional-mode constant shall be adjustable from 0 to 200 percent of input signal range, the integral-mode constant shall be adjustable from 0 to 20 repeats per minute, and derivative-mode constant shall be adjustable from 0 to 5 minutes.

## 2.13 CONTROL DEVICES AND ACCESSORIES

Control device and accessory input impedance shall not exceed 250 ohms.

### 2.13.1 Function Modules

Function modules shall accept mAdc analog input signals to produce mAdc analog output signals or contact output signals. Modules shall have zero and span adjustments for analog outputs, and setpoint adjustments for contact outputs. Module output span accuracy shall be plus or minus 1 percent of input span. Modules shall be rail-mounted as shown. Power consumption shall be not greater than 5 watts.

#### 2.13.1.1 Minimum-Position Switch and Temperature-Setpoint Device

Minimum-position switch and temperature-setpoint device shall accept a 1000 ohms potentiometer input and shall produce a steady analog output. In temperature setpoint applications the potentiometer shall be single-turn, suitable for wall mounting, enclosed in a locking metal or heavy duty plastic enclosure and shall have a graduated dial corresponding to the range of the setpoint adjustment. In a minimum position switch application the potentiometer shall be mounted on or internal to the minimum position switch. The device shall have its input signal electrically or optically isolated from output. Mounting socket shall be an 8 pin base with pins 1, 2, 3 ac power input, 4, 5, 6 input signal, 7, 8, output signal.

#### 2.13.1.2 Signal-Inverter Modules

Signal inverter shall accept an analog input signal and shall have sufficient output capacity to drive the output signal through a circuit with an impedance of not less than 600 ohms. The output shall be electrically isolated from the input and the device shall have a moisture resistant coating. Mounting socket shall be an 8 pin base with pins 1, 2, 3 ac power input, 4, 5, 6 input signal, 7, 8, output signal.

#### 2.13.1.3 High-Low Signal Selector

High-low signal-selector modules shall accept analog input signals and select either the highest or the lowest input signal as the output signal. The signal selector shall be powered by 120 Vac and the output signal shall be electrically isolated from the input signal.

#### 2.13.1.4 Sequencer Modules (Dual Limit Alarm)

Sequencer modules (dual limit alarms) shall accept an analog input signal and shall provide two contact closure outputs. Each output shall have an adjustable independent contact setpoint with an adjustable switching differential range between 1 percent and 100 percent of the input span. The setpoint shall be adjustable between 0 percent and 100 percent of the input span. Setpoint and switching differential (deadband) adjustment potentiometers shall be internal, top-accessed potentiometers or screws. Sequencers shall return all contacts to their zero input signal condition when power is interrupted. The device shall have moisture resistant coating.



#### 2.13.1.5 Loop Driver Modules

Loop driver module shall accept an analog input signal and shall have a circuit input impedance not greater than 100 ohms. The loop driver module shall have sufficient output capacity to drive the output signal through a circuit with an impedance range of not less than 1000 ohms. The output shall be electrically isolated from the input and the device shall have moisture resistant coating. Mounting socket shall be an 8 pin base with pins 1, 2, 3 ac power input, 4, 5, 6 input signal, 7, 8 output signal.

#### 2.13.2 Relays

Relays shall be 2-pole, double-throw (2PDT) with a 10-ampere resistive rating at 120 Vac, and shall have an enclosed 120-Vac coil with 8 pin blade connectors, and a matching rail-mounted socket. Power consumption shall not be greater than 3 watts.

#### 2.13.3 Time-Delay Relays

Time delay relays shall be 2PDT with 8 pin connectors, dust cover, and a matching rail-mounted socket. Adjustable timing range shall be 0 to 5 minutes. Power consumption shall be not greater than 3 watts.

#### 2.13.4 Time Clocks

Time clocks are not required or used. Time wise control of systems shall be thorough signals from the post-wide Williams EMCS.

#### 2.13.5 Current-to-Pneumatic (IP) Transducers

The transducers shall be 2-wire current-to-pressure transmitters that convert a 4-to-20 mA<sub>dc</sub> input signal to a 21 to 103 kPa, or a 103 to 21 kPa, pneumatic output, with a conversion accuracy of plus or minus 2 percent of full scale, including linearity and hysteresis. Input impedance shall not exceed 250 ohms. Air consumption shall not be greater than 0.12 L/s.

#### 2.13.6 Direct Current (DC) Power Supply

One DC power supply shall be used to power all transmitters connected to the control panel. The power supply shall be 24 V<sub>dc</sub> at not less than 1.2 amperes, with a peak-to-peak ripple not to exceed 0.03 percent of output voltage. Each power supply shall have a fused input, and shall be protected from voltage surges and power line transients. The power supply output shall be protected against over voltage and short circuits.

### 2.14 PILOT LIGHTS AND MANUAL SWITCHES

Pilot lights and switches shall be rectangular devices arranged in a horizontal matrix as shown. Momentary switches shall be non-illuminated. Interlocking switches shall have separately illuminated sections. Split legend lights shall have separately illuminated sections. Device illumination shall be by light-emitting diode or neon lamp.

## 2.15 HVAC SYSTEM CONTROL PANELS

### 2.15.1 Panel Assembly

The control panel shall be factory assembled and shipped to the job site as a single unit. The panel shall be fabricated as shown, and the devices shall be mounted as shown. Each panel shall be fabricated as a bottom-entry connection point for control-system electric power, control-system main air source, control-system wiring, pneumatic tubing, interconnection of control systems, interconnection of starters and external shutdown devices, and energy monitoring and control systems (EMCS) interface. Each panel shall have an operating temperature rise of not greater than 11 degrees C above an ambient temperature of 38 degrees C.

### 2.15.2 Panel Electrical Requirements

Each control panel shall be powered by nominal 120 volts ac, fused at 5 amps, terminating at the panel on terminal blocks. Instrument cases shall be grounded. Interior panel, interior door, and exterior panel enclosure shall be grounded.

### 2.15.3 Enclosure

The enclosure for each panel shall be a NEMA 12 single-door wall-mounted box conforming to NEMA 250, with continuous hinged and gasketed exterior door with print pocket and key lock, continuous hinged interior door, interior back panel, and ventilation louvers in back surface as shown. Inside finish shall be white enamel, and outside finish shall be gray primer over phosphatized surfaces.

### 2.15.4 Mounting and Labeling

Controllers, pilot lights, switches, IP's, and pressure gauge shall be mounted on the interior door as shown. Power conditioner, fuses and duplex outlet shall be mounted on the interior of the cabinet as shown. All other components housed in the panel shall be mounted on the interior back panel surface of the enclosure, behind the door on rails as shown. Controllers, switches, pilot lights and gauges mounted on the front of the inner door shall be identified by a plastic or metal nameplate as shown that is mechanically attached to the panel. Function modules, relays, IP transducers, DC power supply, and other devices interior to the panel shall be identified by a plastic or metal nameplate that is mechanically attached to the panel. The nameplate shall have the inscription as shown or where a required description is not given in the contract document, provide an approved, logical device description matching project equipment requirements and labeling conventions. Lettering shall be cut or stamped into the nameplate to a depth of not less than 0.4 mm, and shall show a contrasting color, produced by filling with enamel or lacquer or by the use of a laminated material. Painting of lettering directly on the surface of the interior door or panel is not permitted.

### 2.15.5 Wiring and Tubing

#### 2.15.5.1 Wiring Identification

All wiring connected to controllers, time clocks and function modules shall be identified by function and polarity with full word identifiers, i.e., process variable input, remote setpoint input and control output.

#### 2.15.6 EMCS Terminal Blocks

Terminal blocks shall be provided for connections to EMCS as shown. Analog signals shall require only the removal of jumpers to interface to EMCS. All EMCS terminals shall be wired from the control panel to the EMCS DTC, if required by these specifications.

## 3 EXECUTION

### 3.1 GENERAL INSTALLATION CRITERIA

The HVAC control system shall be installed and ready for operation, as specified and shown. Dielectric isolation shall be provided where dissimilar metals are used for connection and support. Penetrations through and mounting holes in the building exterior shall be made watertight. The HVAC control system installation shall provide clearance for control system maintenance by maintaining access space between coils, access space to mixed-air plenums, and other access space required to calibrate, remove, repair, or replace control system devices. The control system installation shall not interfere with the clearance requirements for mechanical installation shall not interfere with the clearance requirements for mechanical and electrical system maintenance.

#### 3.1.1 Device Mounting Criteria

Devices mounted in or on piping or ductwork, on building surfaces, in mechanical/electrical spaces, or in occupied space ceilings shall be installed in accordance with manufacturer's recommendations and as shown. Control devices to be installed in piping and ductwork shall be provided with all required gaskets, flanges, thermal compounds, insulation, piping, fittings, and manual valves for shutoff, equalization, purging, and calibration. Strap-on temperature sensing elements shall not be used except as specified.

#### 3.1.2 Wiring Criteria

Wiring external to control panels, including low-voltage wiring, shall be installed in metallic raceways. Wiring shall be installed without splices between control devices and HVAC control panels. Cables and conductors shall be tagged at both ends, with the identifier shown on the shop drawings, in accordance with the requirements of Section 16415 ELECTRICAL WORK, INTERIOR. Other electrical work shall be as specified in Section 16415 ELECTRICAL WORK, INTERIOR and as shown.

#### 3.1.3 Controller Output Loop Impedance Limitation

Controller output loops shall be constructed so that total circuit impedance connected to the analog output of a single-loop controller shall not exceed 600 ohms.

### 3.2 CONTROL SYSTEM INSTALLATION

#### 3.2.1 Damper Actuators

Actuators shall not be mounted in the air stream. Multiple actuators operating a common damper shall be connected to a common drive shaft. Actuators shall be installed so that their action shall seal the damper to the extent required to maintain leakage at or below the specified rate and shall move the blades smoothly.

#### 3.2.2 Room-Instrument Mounting

Room instruments shall be mounted so that their sensing elements are 1.5 m above the finished floor unless otherwise shown. Temperature setpoint device shall be recess mounted.

#### 3.2.3 Low-Temperature-Protection Thermostats or Freezestat

For each 1.8 square meters of coil-face area, or fraction thereof, a thermostat shall be provided to sense the temperature at the location shown. The thermostat sensing element shall be installed in a serpentine pattern.

#### 3.2.4 Averaging-Temperature Sensing Elements

Sensing elements shall have a total-element minimum length equal to 3.3 linear meter per square meter of duct cross-sectional area.

#### 3.2.5 Indication Devices Installed in Piping and Liquid Systems

Gauges in piping systems subject to pulsation shall have snubbers. Thermometers and temperature sensing elements installed in liquid systems shall be installed in thermowells. Thermometer and temperature sensing element sensing stems shall extend into the pipe  $\frac{1}{2}$  of the inner diameter. Install all temperature indicating and sensing devices with temperature transfer paste to thoroughly transfer energy from the sensing device to the thermowell and vice-versa. Additionally, extra exposed length of thermowell or sensor stems shall be insulated with the same material as the surrounding piping to ensure accurate temperature measurement.

### 3.3 CONTROL SEQUENCES OF OPERATION

#### 3.3.1 System Requirements

These requirements shall apply to all primary HVAC systems unless modified herein. The sequences describe the actions of the control system for one direction of change in the HVAC process analog variable, such as temperature, humidity or pressure. The reverse sequence shall occur when the direction of change is reversed.

##### 3.3.1.1 HVAC System Supply Fan Operating

HVAC system outside-air, return-air, and relief-air dampers shall function as described hereinafter for specific modes of operation. Interlocked exhaust fans shall be stopped in the unoccupied and ventilation delay modes and their dampers shall be closed. Interlocked exhaust fans shall run in the occupied mode, and their dampers shall open. The dryer exhaust and mud

room exhaust fans shall be interlocked to run continuously when air handler 4-AHU-2 is on and be on continuously even when 4-AHU-2. Cooling-coil control valves shall function as described hereinafter for the specific modes of operation unless their control is assumed by the freeze-protection system. Heating coil valves shall be under control.

#### 3.3.1.2 HVAC System Supply Fan Not Operating

When an HVAC system is stopped, all interlocked fans shall stop (not dryer or mud room exhaust fans), the outside-air and relief-air dampers shall close, the return-air damper shall open, and cooling-coil valves for coils located indoors shall close to the coil. Heating-coil valves shall remain under control.

#### 3.3.1.3 HVAC System Hydronic Heating Distribution Pump Operation

Hydronic supply water temperature mixing valves shall be under control.

#### 3.3.1.4 HVAC System Hydronic Heating Distribution Pump Not Operating

Hydronic supply water temperature mixing valves shall be under control.

#### 3.3.2 Unit-Heater

All Modes - A wall-mounted thermostat with an "AUTO-OFF-HAND" switch located as shown, shall cycle the fan to maintain its setpoint as shown when the switch is in the "AUTO" position. When the switch is in the "OFF" position, the fan shall be stopped. In the "HAND" position, the fan shall run continuously however, heating shall not be available.

#### 3.3.3 Fan-Coil Unit (Barracks Buildings)

A wall-mounted thermostat, located as shown, shall cycle the heating or cooling valve as selected by the heat-off-cooling manual switch at the wall thermostat to maintain the setpoint as shown. The manual switch at the thermostat shall allow occupant selection of heating, cooling or system off. The fan shall run continuously (with the heat-off-cool switch in heat or cool) to provide outside ventilation air when the t-stat heating or cooling switch is either in heating or cooling position. The fan shall be off and coils either bypass or shut off to flow when the heat-off-cool switch is in the off position. When the selector switch is in the heating position and the t-stat is calling for heating the three-way valve shall move from bypass to full flow through the coil, when the space is satisfied the coil shall again be bypassed. When the selector switch is in the cooling position and the t-stat is calling for cooling, the two-way valve shall open to allow full flow through the coil, when the space is satisfied the coil valve shall close off all flow through the coil. Fan speed shall be controlled by the three-speed occupant switch at the thermostat.

#### 3.3.4 Fan-Coil Unit (Community Building 2)

The control sequence shall be as shown.

#### 3.3.5 Central Plant Hydronic-Heating (Community Building 2)

- a. The heating system equipment and pumps shall be enabled by an EMCS relay contact when the H-O-A switch is in the auto position. The

heating system equipment and pumps shall be enabled locally when the H-O-A switch is in the hand position. The heating system equipment and pumps shall be totally disabled when the H-O-A switch is in the off position. Auto and Hand H-O-A switch positions: The outside-air temperature controller shall accept a signal at its process variable input from a sun shielded outside-air temperature sensing element and transmitter located on a north wall. The outside-air temperature controller process variable relay contact output shall start and stop pumps at the outside-air temperatures shown. The analog output of the outside-air temperature controller shall send a signal to the remote setpoint input of the primary hydronic-heating system temperature controller to reset the hydronic-heating supply temperature setpoint in a linear schedule based on the outside-air temperature as shown. Additionally, the EMCS shall be installed to provide an over-riding outside air, hot water supply temperature reset input to the heating hot water supply mixing controller. The hydronic-heating supply temperature controller shall accept a signal at its process variable input from a temperature sensing element and transmitter located in the hydronic-heating supply line and the controller output shall modulate the mixing valve to mix hot water storage tank water and heating return water to maintain the reset schedule setpoint in the hydronic-heating supply line. Once the boilers are energized, they shall fire on a call for heating from hot water storage tank temperature controller, TSL 01-01, under their own factory controls to maintain the hot water storage tank setpoint between the setpoint for TSL 01-01 and TSH 01-01. When the tank temperature is climbs above the setpoint for TSH 01-01, the boilers shall be shut down until the tanks temperature again drops below the lower setpoint for TSL 01-01. Each boilers circulation pump shall continuously when the each boiler is energized.

### 3.3.6 Central Plant Hydronic-Heating (Comm. Bldg 1) Existing Sequence

- a. The outside-air temperature controller shall accept a signal at its process variable input from a sun shielded outside-air temperature sensing element and transmitter located as shown. The outside-air temperature controller process variable relay contact output shall start and stop pump 4-HWP-1 at the outside-air temperatures as shown. The analog output of the outside-air temperature controller shall send a signal to the remote setpoint input of the primary hydronic-heating system temperature controller to reset the hydronic-heating supply temperature in a linear schedule as shown. The hydronic-heating supply temperature controller shall accept a signal at its process variable input from a temperature sensing element and transmitter located in the hydronic-heating supply line as shown and the controller output shall modulate the hot-water control valve to maintain the setpoint in the hydronic-heating supply line.

#### 3.3.6.1 Central Plant Hydronic-Heating (Comm. Bldg 1) Controls for New Equipment

- a. The new boiler (2-HWB-2) and new hot water heating pump (2-HP-2) shown shall be incorporated into the existing heating hot water control system. At this time, as-built controls sequence is not available; The contractor shall be required to obtain as-built information from the Contracting Officers Representative at Ft Sill and submit controls documents showing

complete incorporation of the equipment into the existing controls panel as shown and control of the new equipment using existing and new hardware and equipment.

### 3.3.7 Chilled Water System Control (Community Bldg 1)

a. New chilled water system controls and hardware shall be added to the existing heating and cooling control panel in the mechanical room as shown. Chiller shall be provided with a new lead/lag controller to start and stop on chiller and then the next if the cooling load is too great for the lead chiller.

Chiller controls shall be under the overall control of the chiller lead/lag controller as far as starting but once started each chiller shall attempt to maintain its original (4-CH-1) or new (2-CH-2) design leaving chilled water temperature in the chilled water storage tank.

When the water temperature sensor near the bottom of the chilled water storage tank senses a tank temperature of 5.83 degrees C or greater, the chiller lead/lag controller starts one chiller. If the temperature cannot be maintained at 5.83 deg C (adjustable), the lead/lag controller shall start a second chiller. The chiller lead/lag controller shall start and stop chillers as necessary to maintain the chilled water storage tank temperature. Each chiller's controls shall maintain chiller water service set point temperature of approx. 5.56 deg C.

The chilled water system shall be energized from the heating cooling control panel as shown. The chiller circulating pumps shall run continuously when chilled water is needed as control by the chiller control (in enable pump switch control position) but may be deenergized by the chiller controls. The variable speed main circulating pumps shall be under the control of the pump speed controller once they are energized at the control panel.

The main chilled water supply temperature controller shall modulated the chilled water mixing valve (mixing storage tank water with return chilled water) to maintain the chilled water supply temperature setpoint shown.

### 3.3.8 Chilled Water System Control (Community Bldg 2)

Chilled water system controls and hardware shall be installed in the new heating and cooling control panel in the mechanical room.

When the chiller controls are energized and the chiller starts the chiller circulation pump and proves flow the chiller shall supply chilled water to the tank at its temperature setpoint of 5.56 deg C (adjustable).

The chilled water system shall be energized from the heating cooling control panel as shown. The chiller circulating pump shall run continuously when the chilled water is needed as control by the chiller control (in enable pump switch control position) but may be deenergized by the chiller controls. The variable speed main circulating pumps shall be under the control of the pump speed controller once they are energized at the control panel.

The main chilled water supply temperature controller shall modulated the chilled water mixing valve (mixing storage tank water with return chilled water) to maintain the chilled water supply temperature setpoint shown.

### 3.3.9 Heating and Ventilating Control, 4-AHU-2

#### 3.3.9.1 Operating Mode

In the H-O-A in the hand or auto position the unit shall run continuously to provide heating, ventilation and dryer and mud room exhaust makeup air to the laundry and mud room spaces.

#### 3.3.9.2 Outside-Air Damper

- a. The outside air damper shall be fully open when the unit is energized (fan on and controls energized) and fully closed otherwise.

#### 3.3.9.3 Supply-Fan Control

- a. The supply fan shall run continuously at all times except when the H-O-A switch has been set to off or the power has been disconnected.
- b. Interlocks: Interlocks with 4-EF-1 and 4-EF-2 as shown; both fans shall run continuously when 4-AHU-2 is energized. The fans shall shut down if 4-AHU-2 fan should stop during normal operation as sensed by a current sensing relay on one of the electric supply power feeders to the 4-AHU-2 fan motor.

#### 3.3.9.4 Filter

A differential-pressure switch across the filter shall turn on the filter pilot light when the pressure drop across the filter reaches 125 Pa (adjustable).

#### 3.3.9.5 Freeze Protection

Freezestat (TSL 04-01), located as shown, shall stop the supply fan, cause the outside-air dampers to close; and turn on the low-temperature pilot light in the HVAC control panel if the temperature drops below the freezestat setpoint as shown. To return to normal mode of operation shall require manual reset at the HVAC control panel.

#### 3.3.9.6 Outside Air Pre-heating coil control

All Modes - The preheat-coil temperature controller shall modulate the coil face and bypass dampers actuator from the signal of a temperature-sensing element and transmitter in the coil discharge air to maintain the setpoint as shown. The normally open preheating coil valve shall be fully open to the coil.

#### 3.3.9.7 Space Temperature Control

A space-temperature sensing-element and transmitter operating through a space-temperature controller shall first gradually shut off the heating-coil valve to control temperatures as shown.



### 3.3.9.8 Emergency Fan Shutdown

Activation of a duct smoke detector in the supply-air or return-air ductwork, or activation of a manual emergency fan shutdown switch shall cause the associated fan to shutdown in accordance with NFPA 90A. Activation of these devices shall operate a pilot light on the HVAC control panel. The panel shall require manual resetting after the detector and the manual switch are reset.

### 3.3.10 Single-Zone with Hydronic Heating/Cooling Coils, 4-AHU-1

#### 3.3.10.1 Occupied, Unoccupied, and Ventilation-Delay Modes

Ventilation-delay-mode timing shall start prior to the occupied-mode timing. The EMCS shall close a contact, which shall turn on the ventilation-delay pilot light and energize a relay which shall prevent the outside-air damper from opening. At the time determined by the Contracting Officers Representative (COR), the EMCS shall close a contact which shall turn on the occupied-mode pilot light and shall place the system in the occupied mode. At the expiration of the ventilation-delay-mode timing period, the EMCS shall open the contact to turn off the ventilation-delay-mode pilot light and de-energize a relay to allow the outside-air damper to open. At the time determined by the Contracting Officers Representative (COR), the EMCS shall open the contact to turn off the occupied-mode pilot light and shall place the control system in the unoccupied mode of operation.

#### 3.3.10.2 Outside-Air, Return-Air, and Relief-Air Dampers

- a. Occupied Mode - The outside-air, return-air, and relief-air dampers shall be under space temperature and economizer control.
- b. Unoccupied and Ventilation-Delay Modes - The dampers shall return to their normal positions.

#### 3.3.10.3 Supply-Fan Control

- a. Occupied and Ventilation-Delay Modes - Supply fan shall start, and shall operate continuously.
- b. Unoccupied Mode - The supply fan shall cycle from a night thermostat. The fan shall start at and stop at the setpoints as shown.

#### 3.3.10.4 Filter

A differential-pressure switch across the filter shall turn on the filter pilot light when the pressure drop across the filter reaches the dirty filter setpoint of 125 Pa (adjustable).

#### 3.3.10.5 Outside-Air Preheat-Coil Control

All Modes - The preheat-coil temperature controller shall modulate the coil face and bypass dampers actuator from the signal of a temperature-sensing element and transmitter in the coil discharge air to maintain the setpoint as shown. The normally open preheating coil valve shall be fully open to the coil.

#### 3.3.10.6 Freeze Protection

All Modes - A freezestat, located as shown, shall stop the supply fan, cause the outside air, return air, and relief air dampers to return to their normal position as shown, and shall turn on the low-temperature pilot light in the HVAC control panel if the temperature drops below the freezestat's setpoint as shown. Return to the normal mode of operation shall require manual reset at the freezestat and at the HVAC control panel. The preheating and heating coil valves shall open fully to their respective coils.

#### 3.3.10.7 Cooling Coil

All Modes - A temperature controller shall accept signals from a temperature sensing element and transmitter and shall modulate the system control valve to maintain the setpoint as shown.

#### 3.3.10.8 Constant-Temperature Hydronic-Heating Control

All Modes - A temperature controller shall accept signals from a temperature sensing element and transmitter in the heating supply line, and shall modulate the system control valve to maintain the setpoint as shown.

#### 3.3.10.9 Emergency Fan Shutdown

Activation of a duct smoke detector in the supply-air or return-air ductwork, or activation of a manual emergency fan shutdown switch shall cause the associated fan to shutdown in accordance with NFPA 90A. Activation of these devices shall operate a pilot light on the HVAC control panel. The panel shall require manual resetting after the detector and the manual switch are reset.

### 3.4 COMMISSIONING PROCEDURES

#### 3.4.1 General Procedures

##### 3.4.1.1 Evaluations

The Contractor shall make the observations, adjustments, calibrations, measurements, and tests of the control systems, tune the controllers, set the EMCS schedule, and make any necessary control-system corrections to ensure that the systems function as described in paragraph CONTROL SEQUENCES OF OPERATION. The Contractor shall permanently record, on system equipment schedule, the final setting of controller proportional, integral and derivative constant settings, setpoint, manual reset setting, maximum and minimum controller output, and ratio and bias settings, in units and terminology specific to the controller.

##### 3.4.1.2 Item Check

An item-by-item check of the sequence of operation requirement shall be performed using Steps 1 through 4 in the specified control system commissioning procedures. Steps 1, 2, and 3 shall be performed with the HVAC system shutdown; Step 4 shall be performed after the HVAC systems have been started. Signals used to change the mode of operation shall originate from the actual HVAC control device intended for the purpose, such as the time clock. External input signals to the HVAC control panel (such as EMCS, starter auxiliary contacts, and external systems) may be simulated in Steps

1, 2, and 3. With each operational-mode change signal, pilot lights and HVAC-panel output-relay contacts shall be observed to ensure that they function. All terminals assigned to EMCS shall be checked and observed to ensure that the proper signals are available.

#### 3.4.1.3 Weather-Dependent Test Procedures

Weather-dependent test procedures that cannot be performed by simulation shall be performed in the appropriate climatic season. When simulation is used, the Contractor shall verify the actual results in the appropriate season.

#### 3.4.1.4 Configuration

The Contractor shall configure each controller for its specified service.

#### 3.4.1.5 Two-Point Accuracy Check

A two-point accuracy check of the calibration of each HVAC-control-system sensing element and transmitter shall be performed by comparing the HVAC-control-panel readout to the actual value of the variable measured at the sensing element and transmitter or airflow measurement station location. Digital indicating test instruments shall be used, such as digital thermometers, motor-driven psychrometers, and tachometers. The test instruments shall be at least twice as accurate as the specified sensing element-to-controller readout accuracy. The calibration of the test instruments shall be traceable to NIST standards. The first check point shall be with the HVAC system in the shutdown condition, and the second check point shall be with the HVAC system in an operational condition. Calibration checks shall verify that the sensing element-to-controller readout accuracies at two points are within the specified product accuracy tolerances. If not, the device shall be recalibrated or replaced and the calibration check repeated.

#### 3.4.1.6 Insertion, Immersion Temperature

Insertion-temperature and immersion-temperature sensing element and transmitter-to-controller readout calibration accuracy shall be checked at one physical location along the axis of the sensing element.

#### 3.4.1.7 Averaging Temperature

Averaging-temperature sensing element and transmitter-to-controller readout calibration accuracy shall be checked every 1/2 meter along the axis of the sensing element in the proximity of the sensing element, for a maximum of 10 readings. These readings shall then be averaged.

#### 3.4.1.8 Controller Stations

The Contractor shall use the controllers' MANUAL/AUTOMATIC stations as the means of manipulating control devices, such as dampers and valves, to check IP operation and to effect stable conditions prior to making measurement checks.

#### 3.4.1.9 Controller-Tuning Procedure

The Contractor shall perform a controller-tuning procedure, which shall consist of setting the initial proportional, integral, and derivative (PID) mode constants, controller setpoints, and logging the settings. Tuning shall be self-tuning operation by the controller unless manual tuning is necessary.

#### 3.4.1.10 Controller Manual-Tuning Procedure

Where required, the controller manual-tuning procedure shall be performed in three steps. Using a constant-temperature-setpoint controller as an example, these steps are:

a. Step A:

(1) The controller MANUAL/AUTO station shall be indexed to the AUTO position and the integral- and derivative-mode constants set to zero.

(2) The proportional-mode constant shall be set to an initial setting of 8 percent. (This corresponds to 18.6 kPa per degree C or 3.6 ma per degree C proportional controller output change for a 55.5 degree C transmitter span.) This causes the controller output signal to vary from live zero output to full output for an input signal change representing an 4.5 degree C change.

(3) Controllers for other variables, such as relative humidity and static pressure, shall have their proportional-mode constants set initially in a similar manner for an achievable output range proportional to the transmitter span.

b. Step B:

(1) The controller temperature setpoint shall be set at any achievable temperature. The controller output and transmitter input shall be observed.

(2) If the transmitter input continuously oscillates above and below the setpoint without settling at a fixed value, or if such oscillation increases, the proportional-mode constant is too small.

(3) If the proportional-mode constant is too small, increase it in steps until the transmitter input indicates stable control at any temperature, provided that the controller output is not at either extreme of the output range.

(4) If the temperature control point slowly drifts toward or away from the controller setpoint, the proportional-mode constant is too large. Its setting shall be decreased in steps until oscillations occur as described in the preceding paragraphs, and then the setting shall be increased until stable control occurs.

(5) A step change in controller setpoint shall be introduced. This should cause the controller to overshoot the setpoint slightly, with each subsequent overshoot peak value decreasing by a

factor of 2/3 until stable control is achieved at, above, or below the setpoint.

(6) Next, the integral-mode constant setting shall be increased in small steps, and setpoint changes shall be introduced until control point and controller setpoint coincide at stable control. This should happen consistently after a setpoint change within a short time, such as 5 to 10 minutes.

c. Step C:

(1) Unless the HVAC process variable changes rapidly, the derivative-mode constant setting can remain at zero.

(2) If derivative control is needed, the derivative-mode constant shall be gradually increased.

(3) Step changes in controller setpoint shall be introduced, and the derivative-mode constant setting adjusted until stable control is achieved.

#### 3.4.1.11 Setting the Controller

After the controller manual-tuning procedure is complete, the controller shall be set at the setpoint as shown.

#### 3.4.2 Unit Heater

The "OFF/AUTO" switch shall be placed in the "OFF" position. Each space-thermostat temperature setting shall be turned up so that it makes contact to turn on the unit-heater fans. The unit-heater fans shall not start. The "OFF/AUTO" switch shall be placed in the "AUTO" position. The unit-heater fans shall start. Each space-thermostat temperature setting shall be turned down, and the unit-heater fans shall stop. The thermostats shall be set at the temperature setpoints as shown. The results of testing of one of each type of unit shall be logged.

#### 3.4.3 Fan-Coil-Unit

The dual-temperature hydronic system shall be set to heating. Each space thermostat temperature setting shall be turned up so that it makes contact and turns the fan-coil unit on. The fan-coil unit fan shall start and the valves shall open to flow through the coils. Each space thermostat temperature setting shall be turned down and the fan-coil unit fans shall stop. The valves shall close to flow through the coils. The dual-temperature hydronic system shall be switched to cooling. Each space thermostat temperature setting shall be turned up; contact shall be broken and the fan-coil unit fans shall stop. The valves shall close to flow through the coil. Each space thermostat temperature setting shall be turned down. The fan-coil unit fans shall start and the valves shall open to flow through the coils. The thermostats shall be set at the temperature setpoints as shown. The results of testing of one of each type of unit shall be logged.

#### 3.4.4 Central Plant High-Temperature Hot-Water Hydronic-Heating

Steps for installation shall be as follows:

- a. Step 1 - System Inspection: The HVAC system shall be observed in its shutdown condition. Power and main air shall be available at the HVAC system control panel. The converter valve shall be closed.
- b. Step 2 - Calibration Accuracy Check with HVAC System Shutdown: Readings shall be taken with a digital thermometer at each temperature sensing element location. Each controller display shall be read, and the thermometer and controller-display readings logged. The calibration accuracy of the sensing element-to-controller readout for outside-air temperature and system-supply temperature shall be checked.
- c. Step 3 - Actuator Range Adjustments: A signal shall be applied to the actuator, using the controller "MANUAL/AUTO" station in "MANUAL." The proper operation of the actuators and positioners for all valves shall be verified. The signal shall be varied from live zero of 4 ma [or 21 kPa] to 20 ma [or 103 kPa ], and it shall be verified that the actuators travel from zero stroke to full stroke within the signal range. It shall be verified that all sequenced actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other.
- d. Step 4 - Control-System Commissioning:
  - (1) The outside-air temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position and the two-point calibration sensing element-to-controller readout accuracy check for the outside-air temperature shall be performed. The controller proportional band adjustment, the setpoint, the manual reset, and the maximum controller output shall be set to achieve the outside-air temperature schedule as shown.
  - (2) A signal shall be applied to simulate that the outside-air temperature is above the setpoint as shown. It shall be verified that pump [\_\_\_\_\_] stops. A signal shall be applied to simulate that the outside-air temperature is below the setpoint as shown. It shall be verified that pump [\_\_\_\_\_] starts.
  - (3) The system's supply-temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position, and the two-point calibration accuracy check of the sensing element-to-controller readout for the system-supply temperature shall be performed. The controller shall be placed in the remote-setpoint mode. The remote setpoint shall be set for temperature schedule as shown. The controller "MANUAL/AUTO" station shall be indexed to the "AUTO" position, and the controller setup and tuning procedures performed. The controller shall be set at a system-supply temperature setpoint within the range as shown and the mode-constant setpoints logged. Signals of 8 ma and 16 ma shall be sent to the remote setpoint, from the outside-air temperature controller, to verify that the controller setpoint changes to the appropriate values. The outside-air temperature controller's "MANUAL/AUTO" station shall be indexed to "AUTO." A high-temperature condition shall be initiated in the system supply line

by lowering the thermostat setting. It shall be verified that the high-temperature hot-water shutoff valve closes and the pilot light turns on. The thermostat shall be set at the setting shown, the safety circuit shall be manually reset, and it shall be verified that the shutoff valve opens and the pilot light turns off.

(4) An occupied-mode signal shall be applied. Each space-temperature controller "MANUAL/AUTO" station shall be indexed to "MANUAL". The calibration accuracy check of sensing element-to-controller readout for each space temperature shall be performed, and the values logged. The controller shall be placed in the remote-setpoint mode. The setpoint low-end limit shall be set to 19 degrees C and the high-end limit shall be set to 22 degrees C. The proper action of the temperature-setpoint device at the space-temperature sensing element and transmitter location shall be verified. Each controller "MANUAL/AUTO" station shall be indexed to the "AUTO" position, and the controller-tuning procedure shall be performed. An unoccupied-mode signal shall be applied, and it shall be verified that each controller's setpoint changes to the unoccupied-mode setting. The temperature setpoint device shall be set to the space-temperature setpoint as shown.

#### 3.4.5 Heating and Ventilating

Steps for installation are as follows:

- a. Step 1 - System Inspection: The HVAC system shall be observed in its shutdown condition. Power and main air shall be available at the HVAC system control panel. The outside-air damper and relief-air damper shall be closed and the return-air damper shall be open.
- b. Step 2 - Calibration Accuracy Check with HVAC System Shutdown: Readings shall be taken with a digital thermometer at each temperature-sensing element location. Each controller display shall be read, and the thermometer and controller-display readings logged. The calibration accuracy of the sensing element-to-controller readout for space temperature shall be checked.
- c. Step 3 - Actuator Range Adjustments: A signal shall be applied to the actuator, using the controller "MANUAL/AUTO" station in "MANUAL." The proper operation of the actuators and positioners for all dampers and valves shall be verified. The signal shall be varied from live zero of 4 ma [or 21 kPa ] to 20 ma [or 103 kPa ], and it shall be verified that the actuators travel from zero stroke to full stroke within the signal range. It shall be verified that all sequenced and parallel-operated actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other.
- d. Step 4 - Control-System Commissioning:
  - (1) With the fan ready to start, the ventilation-delay-mode signal shall be applied, and it shall be verified that the ventilation-delay-mode pilot light turns on. The occupied-mode signal shall be applied and it shall be verified that the occupied-mode pilot light turns on and that supply fan [\_\_\_\_\_] starts. It shall be

verified that the outside-air and relief-air dampers are closed, the return-air damper is open, and the heating-coil valve is under control, by slightly changing the controller outputs. The ventilation-delay-mode signal shall be released, and it shall be verified that the ventilation-delay-mode pilot light turns off and that the outside-air, return-air, and relief-air dampers come under control by changing the controller output.

(2) The minimum-outside-air-mode signal shall be applied. It shall be verified that the outside-air damper opens to minimum position and the economizer pilot light is off.

(3) The space-temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position, and the calibration accuracy check for sensing element-to-controller readout shall be performed. The controller shall be placed in the remote-setpoint mode. The setpoint low-end limit shall be set to 19 degrees C and the high-end limit shall be set to 22 degrees C. Proper operation of the temperature setpoint device at the space temperature sensing element and transmitter location shall be verified. The controller "MANUAL/AUTO" station shall be indexed to the "AUTO" position and the controller-tuning procedure shall be performed. The temperature setpoint device shall be set to the space temperature setpoint as shown.

(4) An unoccupied-mode signal shall be applied, and it shall be verified that the occupied-mode pilot light turns off, the HVAC system shuts down, and the control system assumes the specified shutdown conditions. The night-thermostat temperature setting shall be turned upward, and it shall be verified that the HVAC system starts; the setting shall be turned downward, and it shall be verified that the HVAC system stops. The night thermostat shall be set at the setpoint as shown.

(5) With the HVAC system running, a filter differential-pressure switch input signal shall be simulated, at the device. It shall be verified that the filter pilot light turns on, and that contact output at EMCS terminals is made. The differential-pressure switch shall be set at the setpoint as shown.

(6) With the HVAC system running, a freezestat trip input signal shall be simulated, at the device. HVAC system shutdown shall be observed. It shall be verified that the low-temperature pilot light turns on and that contact output at the EMCS terminals is made. The freezestat shall be set at the setpoint as shown. The HVAC shall be restarted by manual restart, and it shall be verified that the pilot light turns off.

(7) With the HVAC system running, a smoke-detector trip input signal shall be simulated at each detector, and verification of control-device actions and interlock functions as described in paragraph CONTROL SEQUENCES OF OPERATION shall be made. Simulation shall be performed without false-alarming any Life Safety systems. It shall be verified that the HVAC system shuts down and that the smoke-detector pilot light turns on, and contact output at EMCS terminals shall be verified. The detectors shall be reset. The



HVAC system shall be restarted by manual reset, and it shall be verified that the pilot light turns off.

#### 3.4.6 Single-Zone with Hydronic Heating and Cooling Coils; No Return Fan

Steps for installation shall be as follows:

- a. Step 1 - System Inspection: The HVAC system shall be verified in its shutdown condition. Power and main air shall be available at the HVAC system control panel. The outside-air and relief-air dampers shall be closed, the return-air damper shall be open, and the cooling-coil valve shall be closed.
- b. Step 2 - Calibration Accuracy Check with HVAC System Shutdown: Readings shall be taken with a digital thermometer at each temperature-sensing element location. Each controller display shall be read, and the thermometer and controller-display readings logged. The calibration accuracy of the sensing element-to-controller readout for outside-air, return-air, and space temperatures shall be checked.
- c. Step 3 - Actuator Range Adjustments: A signal shall be applied to the actuator, using the controller "MANUAL/AUTO" station in "MANUAL." The proper operation of the actuators and positioners for all dampers and valves shall be verified. The signal shall be varied from live zero of 4 ma [or 21 kPa ] to 20 ma [or 103 kPa ], and it shall be verified that the actuators travel from zero stroke to full stroke within the signal range. It shall be verified that all sequenced and parallel-operated actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other.
- d. Step 4 - Control-System Commissioning:
  - (1) With the fan ready to start, the ventilation-delay-mode signal shall be applied, and it shall be verified that the ventilation-delay-mode pilot light turns on. The occupied-mode signal shall be applied, and it shall be verified that the occupied-mode pilot light turns on and that supply fan [\_\_\_\_\_] starts. It shall be verified that the outside-air and relief-air dampers are closed, the return-air damper is open, and the heating-coil and cooling-coil valves are under control, by slightly changing the controller outputs. The ventilation-delay-mode signal shall be released, and it shall be verified that the ventilation-delay-mode pilot light turns off and that the outside-air, return-air, and relief-air dampers come under control by changing the controller output.
  - (2) The minimum-outside-air-mode signal shall be applied. It shall be verified that the outside-air damper opens to minimum position and the economizer pilot light is off.
  - (3) The space-temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position. An economizer-mode input signal shall be simulated and it shall be verified that the economizer-mode pilot light turns on. The space-temperature controller output shall be changed and the second point of the two-

point calibration accuracy check of sensing element-to-controller readout for outside-air, return-air, and space temperatures shall be performed. The controller shall be placed in the remote-setpoint mode. The setpoint low-end limit shall be set to 19 degrees C and the high-end limit shall be set to 22 degrees C. Proper operation of the temperature setpoint device at the space-temperature sensing element and transmitter location shall be verified. The space-temperature controller tuning procedure shall be performed. The controller "MANUAL/AUTO" station shall be indexed to the "AUTO" position and the temperature setpoint device shall be set to the space temperature setpoint as shown. A change in space temperature shall be simulated and it shall be verified that the heating-coil valve and the cooling-coil valve operate in sequence as shown.

(4) An unoccupied-mode signal shall be applied, and it shall be verified that the occupied-mode pilot light turns off, the HVAC system shuts down, and the control system assumes the specified shutdown conditions. The night-thermostat temperature setting shall be turned upward, and it shall be verified that the HVAC system starts; the setting shall be turned downward, and it shall be verified that the HVAC system stops. The night thermostat shall be set at the setpoint as shown.

(5) With the HVAC system running, a filter differential-pressure switch input signal shall be simulated at the device. It shall be verified that the filter pilot light turns on, and that contact output at the EMCS terminals is made. The differential-pressure switch shall be set at the setpoint as shown.

(6) With the HVAC system running, a freezestat trip input signal shall be simulated at the device. HVAC system shutdown shall be verified, the low-temperature pilot light shall turn on, and contact output at the EMCS terminals shall be verified. The freezestat shall be set at the setpoint as shown. The HVAC system shall be restarted by manual restart, and it shall be verified that the pilot light turns off.

(7) With the HVAC system running, a smoke-detector trip input signal shall be simulated at each detector, and control-device actions and interlock functions, as described in paragraph CONTROL SEQUENCES OF OPERATION shall be verified. Simulation shall be performed without false-alarming any Life Safety systems. It shall be verified that the HVAC system shuts down and that the smoke-detector pilot light turns on, and contact output at the EMCS terminals is made. The detectors shall be reset. The HVAC system shall be restarted by manual restart, and it shall be verified that the pilot light turns off.

### 3.5 BALANCING, COMMISSIONING, AND TESTING

#### 3.5.1 Coordination with HVAC System Balancing

Commissioning of the control system, except for tuning of controllers, shall be performed prior to or simultaneous with HVAC system balancing. The Contractor shall tune the HVAC control system after all air-system and

hydronic-system balancing has been completed, minimum damper positions set and a report has been issued.

### 3.5.2 Control System Calibration, Adjustments, and Commissioning

Control system commissioning shall be performed for each HVAC system, using test plans and procedures previously approved by the Government. The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform commissioning and testing of the HVAC control system. All instrumentation and controls shall be calibrated and the specified accuracy shall be verified using test equipment with calibration traceable to NIST standards. Wiring shall be tested for continuity and for ground, open, and short circuits. Tubing systems shall be tested for leaks. Mechanical control devices shall be adjusted to operate as specified. HVAC control panels shall be pretested off-site as a functioning assembly ready for field connections, calibration, adjustment, and commissioning of the operational HVAC control system. Written notification of any planned commissioning or testing of the HVAC Control systems shall be given to the Government at least 14 calendar days in advance.

### 3.5.3 Performance Verification Test

The Contractor shall demonstrate compliance of the HVAC control system with the contract documents. Using test plans and procedures previously approved by the Government, the Contractor shall demonstrate all physical and functional requirements of the project. The performance verification test shall show, step-by-step, the actions and results demonstrating that the control systems perform in accordance with the sequences of operation. The performance verification test shall not be started until after receipt by the Contractor of written permission by the Government, based on Government approval of the commissioning report and completion of balancing. The tests shall not be conducted during scheduled seasonal off-periods of base heating and cooling systems.

### 3.5.4 Posted and Panel Instructions

Posted and panel instructions, showing the final installed conditions, shall be provided for each system. The posted instructions shall consist of half-size laminated drawings and shall include the control system schematic, equipment schedule, ladder diagram, sequence of operation, panel arrangement drawings, wiring diagram, and valve and damper schedules. The posted instructions shall be permanently affixed, by mechanical means, to a wall near the control panel. Panel instructions shall consist of laminated letter-size sheets and shall include a routine maintenance checklist and controller configuration check sheets with final configuration record for each controller. Panel instructions and one copy of the operation and maintenance manuals, previously described herein, shall be placed inside each control panel.

## 3.6 TRAINING

### 3.6.1 Training-Course Requirements

A training course shall be conducted for 6 operating staff members designated by the Contracting Officer. The training period, for a total of 32 hours of normal working time, shall be conducted within 30 days after successful completion of the performance verification test. The training

course shall be conducted at the project site. Audiovisual equipment and 6 sets of all other training materials and supplies shall be provided. A training day is defined as 8 hours of classroom instruction, including two 15-minute breaks and excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility.

### 3.6.2 Training-Course Content

For guidance in planning the required instruction, the Contractor shall assume that attendees will have a high school education or equivalent, and are familiar with HVAC systems. The training course shall cover all of the material contained in the operating and maintenance instructions, the layout and location of each HVAC control panel, the layout of one of each type of unitary equipment and the locations of each, the location of each system-control device external to the panels, the location of the compressed-air station, preventive maintenance, troubleshooting, diagnostics, calibration, adjustment, commissioning, tuning, and repair procedures. Typical systems and similar systems may be treated as a group, with instruction on the physical layout of one such system. The results of the performance verification test and the calibration, adjustment and commissioning report shall be presented as benchmarks of HVAC control-system performance by which to measure operation and maintenance effectiveness.

## SECTION 15990

## TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## ASSOCIATED AIR BALANCE COUNCIL (AABC)

AABC MN-1 (1989) National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems

## NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

NEBB-01 (1991) Procedural Standards for Testing Adjusting Balancing of Environmental Systems

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having a "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-01 Data

TAB Related HVAC Submittals; FIO.

A list of the TAB Related HVAC Submittals, no later than 7 days after the approval of the TAB Specialist.

## SD-04 Drawings

TAB Schematic Drawings and Report Forms; GA.

Three copies of the TAB Schematic Drawings and Report Forms, no later than 21 days prior to the start of TAB field measurements.

## SD-06 Instructions

TAB Procedures; GA.

Proposed procedures for TAB, submitted with the TAB Schematic Drawings and Report Forms.

## SD-07 Schedules

Systems Readiness Check; FIO;.

Proposed date and time to begin the Systems Readiness Check, no later than 7 days prior to the start of the Systems Readiness Check.

TAB Execution; GA;.

Proposed date and time to begin field measurements, making adjustments, etc., for the TAB Report, submitted with the Systems Readiness Check Report.

TAB Verification; GA.

Proposed date and time to begin the TAB Verification, submitted with the TAB Report.

#### SD-08 Statements

TAB Firm; GA.

Certification of the proposed TAB Firm's qualifications by either AABC or NEBB to perform the duties specified herein and in other related Sections, no later than 21 days after the Notice to Proceed. The documentation shall include the date that the Certification was initially granted and the date that the current Certification expires. Any lapses in Certification of the proposed TAB Firm or disciplinary action taken by AABC or NEBB against the proposed TAB Firm shall be described in detail.

TAB Specialist; GA;.

Certification of the proposed TAB Specialist's qualifications by either AABC or NEBB to perform the duties specified herein and in other related Sections, no later than 21 days after the Notice to Proceed. The documentation shall include the date that the Certification was initially granted and the date that the current Certification expires. Any lapses in Certification of the proposed TAB Specialist or disciplinary action taken by AABC or NEBB against the proposed TAB Specialist shall be described in detail.

Instrument Calibration; FIO.

List of each instrument to be used during TAB, stating calibration requirements required or recommended by both the TAB Standard and the instrument manufacturer and the actual calibration history of the instrument, submitted with the TAB Procedures. The calibration history shall include dates calibrated, the qualifications of the calibration laboratory, and the calibration procedures used.

#### SD-09 Reports

Design Review Report; GA.

A copy of the Design Review Report, no later than 14 days after approval of the TAB Firm and the TAB Specialist.

Systems Readiness Check Report; GA.

A copy of completed checklists for each system, each signed by the TAB Specialist, at least 7 days prior to the start of TAB Execution. All items in the Systems Readiness Check Report shall be signed by the TAB Specialist and shall bear the seal of the Professional Society or National Association used as the TAB Standard.

TAB Report; GA.

Three copies of the completed TAB Reports, no later than 7 days after the execution of TAB. All items in the TAB Report shall be signed by the TAB Specialist and shall bear the seal of the Professional Society or National Association used as the TAB Standard.

TAB Verification Report; GA.

Three copies of the completed TAB Verification Report, no later than 7 days after the execution of TAB Verification. All items in the TAB Verification Report shall be signed by the TAB Specialist and shall bear the seal of the Professional Society or National Association used as the TAB Standard.

#### SD-13 Certificates

Ductwork Leak Testing; FIO.

A written statement signed by the TAB Specialist certifying that the TAB Specialist witnessed the Ductwork Leak Testing, it was successfully completed, and that there are no known deficiencies related to the ductwork installation that will prevent TAB from producing satisfactory results.

### 1.3 TAB STANDARD

TAB shall be performed in accordance with the requirements of the standard under which the TAB Firm's qualifications are approved, i.e., AABC MN-1 or NEBB-01, unless otherwise specified herein. All recommendations and suggested practices contained in the TAB Standard shall be considered mandatory. The provisions of the TAB Standard, including checklists, report forms, etc., shall, as nearly as practical, be used to satisfy the Contract requirements. The TAB Standard shall be used for all aspects of TAB, including qualifications for the TAB Firm and Specialist and calibration of TAB instruments. Where the instrument manufacturer calibration recommendations are more stringent than those listed in the TAB Standard, the manufacturer's recommendations shall be adhered to. All quality assurance provisions of the TAB Standard such as performance guarantees shall be part of this contract. For systems or system components not covered in the TAB Standard, TAB procedures shall be developed by the TAB Specialist. Where new procedures, requirements, etc., applicable to the Contract requirements have been published or adopted by the body responsible for the TAB Standard used (AABC or NEBB), the requirements and recommendations contained in these procedures and requirements shall be considered mandatory.

For all air moving systems including ducted and unducted fans, air flows shall be balanced to the following standard, +10%, -0% with no exceptions.

### 1.4 QUALIFICATIONS

#### 1.4.1 TAB Firm

The TAB Firm shall be either a member of AABC or certified by the NEBB and certified in all categories and functions where measurements or performance are specified on the plans and specifications. The certification shall be maintained for the entire duration of duties specified herein. If, for any

reason, the firm loses subject certification during this period, the Contractor shall immediately notify the Contracting Officer and submit another TAB Firm for approval. Any firm that has been the subject of disciplinary action by either the AABC or the NEBB within the five years preceding Contract Award shall not be eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections to be performed by the TAB Firm shall be considered invalid if the TAB Firm loses its certification prior to Contract completion and must be performed by an approved successor.

#### 1.4.2 TAB Specialist

The TAB Specialist shall be either a member of AABC or an experienced technician of the Firm certified by the NEBB. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the Specialist loses subject certification during this period, the Contractor shall immediately notify the Contracting Officer and submit another TAB Specialist for approval. Any individual that has been the subject of disciplinary action by either the AABC or the NEBB within the five years preceding Contract Award shall not be eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections performed by the TAB Specialist shall be considered invalid if the TAB Specialist loses its certification prior to Contract completion and must be performed by the approved successor.

#### 1.5 TAB SPECIALIST RESPONSIBILITIES

All TAB work specified herein and in related sections shall be performed under the direct guidance of the TAB Specialist.

#### 2 PRODUCTS (NOT APPLICABLE)

#### 3 EXECUTION

##### 3.1 DESIGN REVIEW

The TAB Specialist shall review the Contract Plans and Specifications and advise the Contracting Officer of any deficiencies that would prevent the HVAC systems from effectively operating in accordance with the sequence of operation specified or prevent the effective and accurate TAB of the system. The TAB Specialist shall provide a Design Review Report individually listing each deficiency and the corresponding proposed corrective action necessary for proper system operation.

##### 3.2 TAB RELATED HVAC SUBMITTALS

The TAB Specialist shall prepare a list of the submittals from the Contract Submittal Register that relate to the successful accomplishment of all HVAC TAB. The submittals identified on this list shall be accompanied by a letter of approval signed and dated by the TAB Specialist when submitted to the Government. The TAB Specialist shall also ensure that the location and details of ports, terminals, connections, etc., necessary to perform TAB are identified on the submittals.



### 3.3 TAB SCHEMATIC DRAWINGS AND REPORT FORMS

A schematic drawing showing each system component, including balancing devices, shall be provided for each system. Each drawing shall be accompanied by a copy of all report forms required by the TAB Standard used for that system. Where applicable, the acceptable range of operation or appropriate setting for each component shall be included on the forms or as an attachment to the forms. The schematic drawings shall identify all testing points and cross reference these points to the report forms and procedures.

### 3.4 DUCTWORK LEAK TESTING

The TAB Specialist shall witness the Ductwork Leak Testing specified in Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM and approve the results as specified in Paragraph TAB RELATED HVAC SUBMITTALS.

### 3.5 TESTING, ADJUSTING, AND BALANCING

#### 3.5.1 TAB Procedures

Step by step procedures for each measurement required during TAB Execution shall be provided. The procedures shall be oriented such that there is a separate section for each system. The procedures shall include measures to ensure that each system performs as specified in all operating modes, interactions with other components (such as exhaust fans, kitchen hoods, fume hoods, relief vents, etc.) and systems, and with all seasonal operating differences, diversity, simulated loads, and pressure relationships required.

#### 3.5.2 Systems Readiness Check

The TAB Specialist shall inspect each system to ensure that it is complete, including installation and operation of controls, and that all aspects of the facility that have any bearing on the HVAC systems, including installation of ceilings, walls, windows, doors, and partitions, are complete to the extent that TAB results will not be affected by any detail or touch-up work remaining. The TAB Specialist shall also verify that all items such as ductwork and piping ports, terminals, connections, etc., necessary to perform TAB shall be complete during the Systems Readiness Check.

#### 3.5.3 Preparation of TAB Report

Preparation of the TAB Report shall begin only when the Systems Readiness Report has been approved. The Report shall be oriented so that there is a separate section for each system. The Report shall include a copy of the appropriate approved Schematic Drawings and TAB Related Submittals, such as pump curves, fan curves, etc., along with the completed report forms for each system. The operating points measured during successful TAB Execution and the theoretical operating points listed in the approved submittals shall be marked on the performance curves and tables. Where possible, adjustments shall be made using an "industry standard" technique which would result in the greatest energy savings, such as adjusting the speed of a fan instead of throttling the flow. Any deficiencies outside of the realm of normal adjustments and balancing during TAB Execution shall be noted along with a description of corrective action performed to bring the measurement into the

specified range. If, for any reason, the TAB Specialist determines during TAB Execution that any Contract requirement cannot be met, the TAB Specialist shall immediately provide a written description of the deficiency and the corresponding proposed corrective action necessary for proper system operation to the Contracting Officer.

#### 3.5.4 TAB Verification

The TAB Specialist shall recheck ten percent of the measurements listed in the Tab Report and prepare a TAB Verification Report. The measurements selected for verification and the individuals that witness the verification will be selected by the Contracting Officer's Representative (COR). The measurements will be recorded in the same manner as required for the TAB Report. All measurements that fall outside the acceptable operating range specified shall be accompanied by an explanation as to why the measurement does not correlate with that listed in the TAB Report and a description of corrective action performed to bring the measurement into the specified range. If over 20 percent of the measurements selected by the COR for verification fall outside of the acceptable operating range specified, the COR will select an additional ten percent for verification. If over 20 percent of the total tested (including both test groups) fall outside of the acceptable range, the TAB Report shall be considered invalid and all contract TAB work shall be repeated beginning with the Systems Readiness Check.

#### 3.5.5 Marking of Setting

Following approval of TAB Verification Report, the setting of all HVAC adjustment devices including valves, splitters, and dampers shall be permanently marked by the TAB Specialist so that adjustment can be restored if disturbed at any time.

#### 3.5.6 Identification of Test Ports

The TAB Specialist shall permanently and legibly identify the location points of duct test ports. If the ductwork has exterior insulation, the identification shall be made on the exterior side of the insulation. All penetrations through ductwork and ductwork insulation shall be sealed to prevent air leakage or to maintain integrity of vapor barrier.

#### 3.5.7 Sound Level Testing

After the system are properly tested, adjusted and balanced, sound levels shall be checked in accordance with the applicable provisions of AABC MN-1 or NEBB. Octave-band analysis and noise criteria curve data shall be recorded on forms from AABC or NEBB documents. All occupied areas including offices, corridors, auditorium, seating, dormitory rooms, etc. shall be verified to be with the sound levels and NC levels shown or as specified. Any areas not meeting the requirements of AABC Mn-1 or NEBB or the specification or drawings shall be clearly indicated on the form and an explanation of all discrepancies and suggested corrective actions shall be provided in the report.

-- End of Section --

## SECTION 15995

## COMMISSIONING OF HVAC SYSTEMS

## 1 GENERAL

## 1.1 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals with "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

## SD-01 Data

Commissioning Team; GA.

List of team members who will represent the Contractor in the pre-commissioning checks and functional performance testing, at least 2 weeks prior to the start of pre-commissioning checks. Proposed revision to the list, prior to the start of the impacted work.

## SD-06 Instructions

Test Procedures; GA.

Detailed procedures for pre-commissioning checks and functional performance tests, at least 4 weeks prior to the start of pre-commissioning checks.

## SD-07 Schedules

Test Schedule; GA.

Schedule for pre-commissioning checks and functional performance tests, at least 2 weeks prior to the start of pre-commissioning checks.

## SD-09 Reports

Test Reports; GA.

Completed pre-commissioning checklists and functional performance test checklists organized by system and by subsystem and submitted as one package. The results of failed tests shall be included along with a description of the corrective action taken.

## 1.2 SEQUENCING AND SCHEDULING

The work described in this Section shall begin only after all work required in related Sections, including Section 15950 HEATING, VENTILATING, AND AIR CONDITIONING (HVAC) CONTROL SYSTEMS and Section 15990 TESTING, ADJUSTING AND BALANCING OF HVAC SYSTEMS, has been successfully completed, and all test and inspection reports and operation and maintenance manuals required in these Sections have been submitted and approved.

## 2 PRODUCTS (NOT APPLICABLE)

## 3 EXECUTION

### 3.1 COMMISSIONING TEAM AND CHECKLISTS

The Contractor shall designate team members to participate in the pre-commissioning checks and the functional performance testing specified herein. In addition, the Government will be represented by a representative of the Contracting Officer, the Design Agent's Representative, and the Using Agency. The team members shall be as follows:

Designation	Function
Q	Contractor's Chief Quality Control Representative
M	Contractor's Mechanical Representative
E	Contractor's Electrical Representative
T	Contractor's Testing, Adjusting, and Balancing Representative
C	Contractor's Controls Representative
D	Design Agent's Representative
O	Contracting Officer's Representative
U	Using Agency's Representative

Each checklist shown in appendices A and B shall be completed by the commissioning team. Acceptance by each commissioning team member of each pre-commissioning checklist item shall be indicated by initials and date unless an "X" is shown indicating that participation by that individual is not required. Acceptance by each commissioning team member of each functional performance test checklist shall be indicated by signature and date.

### 3.2 TESTS

The pre-commissioning checks and functional performance tests shall be performed in a manner which essentially duplicates the checking, testing, and inspection methods established in the related Sections. Where checking, testing, and inspection methods are not specified in other Sections, methods shall be established which will provide the information required. Testing and verification required by this section shall be performed during the Commissioning phase. Requirements in related Sections are independent from the requirements of this Section and shall not be used to satisfy any of the requirements specified in this Section. The Contractor shall provide all materials, services, and labor required to perform the pre-commissioning checks and functional performance tests. A pre-commissioning check or functional performance test shall be aborted if any system deficiency prevents the successful completion of the test or if any participating non-Government commissioning team member of which participation is specified is not present for the test. The Contractor shall reimburse the Government for all costs associated with effort lost due to tests that are aborted. These costs shall include salary, travel costs and per diem (where applicable) for Government commissioning team members.

#### 3.2.1 Pre-Commissioning Checks

Pre-commissioning checks shall be performed for the items indicated on the checklists in Appendix A. Deficiencies discovered during these checks shall

be corrected and retested in accordance with the applicable contract requirements.

### 3.2.2 Functional Performance Tests

Functional performance tests shall be performed for the items indicated on the checklists in Appendix B. Functional performance tests shall begin only after all pre-commissioning checks have been successfully completed. Tests shall prove all modes of the sequences of operation, and shall verify all other relevant contract requirements. Tests shall begin with equipment or components and shall progress through subsystems to complete systems. Upon failure of any functional performance test checklist item, the Contractor shall correct all deficiencies in accordance with the applicable contract requirements. The checklist shall then be repeated until it has been completed with no errors.

APPENDIX A

PRE-COMMISSIONING CHECKLISTS

## Pre-commissioning checklist - Piping

For Chilled (Ethylene Glycol/Water Mixtures) Piping Systems, Community Building 2.

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Piping complete.	___	___	X	___	X	___	___	___
b. As-built shop drawings submitted.	___	___	X	___	X	___	___	___
c. Piping flushed and cleaned.	___	___	X	___	X	___	___	___
d. Strainers cleaned.	___	___	X	___	X	___	___	___
e. Valves installed as required.	___	___	X	___	X	___	___	___
f. Piping insulated as required.	___	___	X	___	X	___	___	___
g. Thermometers and gauges installed as required.	___	___	X	___	X	___	___	___
h. Verify operation of valves.	___	___	X	___	___	___	___	___
i. Air vents installed as specified.	___	___	X	X	X	___	___	___
j. Flexible connectors installed as specified.	___	___	X	X	X	___	___	___
k. Verify that piping has been labeled and valves identified as specified.	___	___	X	___	___	___	___	___
Testing, Adjusting, and Balancing (TAB)								
a. Hydrostatic test complete.	___	___	X	___	X	___	___	___
b. TAB operation complete.	___	___	X	___	___	___	___	___

## Pre-commissioning checklist - Piping

For Chilled (Propylene Glycol/Water Mixtures) Piping Systems, Community Building 2.

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Piping complete.	___	___	X	___	X	___	___	___
b. As-built shop drawings submitted.	___	___	X	___	X	___	___	___
c. Piping flushed and cleaned.	___	___	X	___	X	___	___	___
d. Strainers cleaned.	___	___	X	___	X	___	___	___
e. Valves installed as required.	___	___	X	___	X	___	___	___
f. Piping insulated as required.	___	___	X	___	X	___	___	___
g. Thermometers and gauges installed as required.	___	___	X	___	X	___	___	___
h. Verify operation of valves.	___	___	X	___	___	___	___	___
i. Air vents installed as specified.	___	___	X	X	X	___	___	___
j. Flexible connectors installed as specified.	___	___	X	X	X	___	___	___
k. Verify that piping has been labeled and valves identified as specified.	___	___	X	___	___	___	___	___
Testing, Adjusting, and Balancing (TAB)								
a. Hydrostatic test complete.	___	___	X	___	X	___	___	___
b. TAB operation complete.	___	___	X	___	___	___	___	___



## For Heating Hot Water Piping System, Community Building 1

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Piping complete.	___	___	X	___	X	___	___	___
b. As-built shop drawings submitted.	___	___	X	___	X	___	___	___
c. Piping flushed and cleaned.	___	___	X	___	X	___	___	___
d. Strainers cleaned.	___	___	X	___	X	___	___	___
e. Valves installed as required.	___	___	X	___	X	___	___	___
f. Piping insulated as required.	___	___	X	___	X	___	___	___
g. Thermometers and gauges installed as required.	___	___	X	___	X	___	___	___
h. Verify operation of valves.	___	___	X	___	___	___	___	___
i. Air vents installed as specified.	___	___	X	X	X	___	___	___
j. Flexible connectors installed as specified.	___	___	X	X	X	___	___	___
k. Verify that piping has been labeled and valves identified as specified.	___	___	X	___	___	___	___	___
Testing, Adjusting, and Balancing (TAB)								
a. Hydrostatic test complete.	___	___	X	___	X	___	___	___
b. TAB operation complete.	___	___	X	___	___	___	___	___

## For Heating Hot Water Piping System, Community Building 2

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Piping complete.	___	___	X	___	X	___	___	___
b. As-built shop drawings submitted.	___	___	X	___	X	___	___	___
c. Piping flushed and cleaned.	___	___	X	___	X	___	___	___
d. Strainers cleaned.	___	___	X	___	X	___	___	___
e. Valves installed as required.	___	___	X	___	X	___	___	___
f. Piping insulated as required.	___	___	X	___	X	___	___	___
g. Thermometers and gauges installed as								

required.	___	___	X	___	X	___	___	___
h. Verify operation of valves.	___	___	X	___	___	___	___	___
i. Air vents installed as specified.	___	___	X	X	X	___	___	___
j. Flexible connectors installed as specified.	___	___	X	X	X	___	___	___
k. Verify that piping has been labeled and valves identified as specified.	___	___	X	___	___	___	___	___
Testing, Adjusting, and Balancing (TAB)								
a. Hydrostatic test complete.	___	___	X	___	X	___	___	___
b. TAB operation complete.	___	___	X	___	___	___	___	___

## Pre-commissioning Checklist - Ductwork

For Air Handler: 4-AHU-1

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Ductwork complete.	___	___	X	___	X	___	___	___
b. As-built shop drawings submitted.	___	___	X	___	X	___	___	___
c. Ductwork leak test complete.	___	___	X	___	X	___	___	___
d. Fire dampers, smoke dampers, and access doors installed as required.	___	___	X	___	X	___	___	___
e. Ductwork insulated as required.	___	___	X	___	X	___	___	___
f. Thermometers and gauges installed as required.	___	___	___	___	___	___	___	___
g. Verify open/closed status of dampers.	___	___	X	___	X	___	___	___
h. Verify smoke dampers operation.	___	___	X	___	___	___	___	___
i. Flexible connectors installed as specified.	___	___	X	___	X	___	___	___
Testing, Adjusting, and Balancing (TAB)								
a. TAB operation complete.	___	___	X	___	X	___	___	___

## Pre-commissioning Checklist - Ductwork

For Air Handler: 4-AHU-2

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Ductwork complete.	___	___	X	___	X	___	___	___
b. As-built shop drawings submitted.	___	___	X	___	X	___	___	___
c. Ductwork leak test complete.	___	___	X	___	X	___	___	___
d. Fire dampers, smoke dampers, and access doors installed as required.	___	___	X	___	X	___	___	___
e. Ductwork insulated as required.	___	___	X	___	X	___	___	___
f. Thermometers and gauges installed as required.	___	___	___	___	___	___	___	___
g. Verify open/closed status of dampers.	___	___	X	___	X	___	___	___
h. Verify smoke dampers operation.	___	___	X	___	___	___	___	___
i. Flexible connectors installed as specified.	___	___	X	___	X	___	___	___
Testing, Adjusting, and Balancing (TAB)								
a. TAB operation complete.	___	___	X	___	X	___	___	___

Pre-commissioning Checklist - Pumps (Reproduce these pages and label for each pump on this project, then submit for approval.)

For Pump: \_\_\_\_\_

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Pumps grouted in place.	___	___	X	X	X	___	___	___
b. Pump vibration isolation devices functional.	___	___	X	X	X	___	___	___
c. Pump/motor coupling alignment verified.	___	___	X	X	X	___	___	___
d. Piping system installed.	___	___	X	X	X	___	___	___
e. Piping system pressure tested.	___	___	X	X	X	___	___	___
f. Pump not leaking.	___	___	X	X	X	___	___	___
g. Field assembled couplings aligned to meet manufacturer's prescribed tolerances.	___	___	X	X	X	___	___	___
Electrical								
a. Power available to pump disconnect.	___	___	___	X	X	___	___	___
b. Pump rotation verified.	___	___	___	X	X	___	___	___
c. Control system interlocks functional.	___	___	___	X	___	___	___	___
d. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___	___	___
Testing, Adjusting, and Balancing (TAB)								
a. Pressure/temperature gauges installed.	___	___	X	___	X	___	___	___
b. Piping system cleaned.	___	___	X	X	X	___	___	___
c. Chemical water treatment complete.	___	___	X	X	X	___	___	___
d. Water balance complete.	___	___	X	___	X	___	___	___
e. Water balance with design maximum flow.	___	___	X	___	X	___	___	___
f. TAB Report submitted.	___	___	X	___	X	___	___	___

Pre-commissioning Checklist - Packaged Air Cooled Chiller, Reproduce these checklists and label individually for each of the chillers in this project and submit for approval.

For Chiller: \_\_\_\_\_

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Chiller properly piped.	___	___	X	___	___	___	___	___
b. Chilled water pipe leak tested.	___	___	X	X	X	___	___	___
c. Verify that refrigerant used complies with specified requirements.	___	___	X	X	X	___	___	___
d. Any damage to coil fins has been repaired.	___	___	X	___	X	___	___	___
e. Manufacturer's required maintenance clearance provided.	___	___	X	X	X	___	___	___
Electrical								
a. Power available to unit disconnect.	___	___	___	X	___	___	___	___
b. Power available to unit control panel.	___	___	___	X	___	___	___	___
c. Separate power is supplied to electric heating tape.	___	___	___	X	___	___	___	___
d. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___	___	___
Controls								
a. Factory startup and checkout complete.	___	___	X	X	___	___	___	___
b. Chiller safety/protection devices tested.	___	___	X	X	___	___	___	___
c. Chilled water flow switch installed.	___	___	X	X	___	___	___	___
d. Chilled water flow switch tested.	___	___	X	X	___	___	___	___
e. Chilled water pump interlock installed.	___	___	X	X	X	___	___	___
f. Chilled water pump interlock tested.	___	___	___	X	___	___	___	___

Pre-commissioning Checklist - Hot Water Boiler, Reproduce these checklists and label individually for each of the boilers in this project and submit for approval.

For Boiler: \_\_\_\_\_

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Boiler flue installed.	___	___	X	___	___	___	___	___
b. Boiler hot water piping installed.	___	___	X	___	___	___	___	___
c. Boiler hot water piping tested.	___	___	X	X	___	___	___	___
d. Boiler makeup water piping installed.	___	___	X	___	___	___	___	___
e. Boiler fuel oil piping installed.	___	___	X	X	X	___	___	___
f. Boiler fuel oil piping tested.	___	___	X	X	X	___	___	___
g. Boiler gas piping installed.	___	___	X	X	X	___	___	___
h. Boiler gas piping tested.	___	___	X	X	X	___	___	___
i. Manufacturer's required maintenance clearance provided.	___	___	X	___	___	___	___	___
Startup								
a. Boiler system cleaned and filled with treated water.	___	___	X	___	___	___	___	___
b. Boiler safety/protection devices, including high temperature burner shut-off, low water cutoff, flame failure, pre and post purge, have been tested.	___	___	___	X	___	___	___	___
c. Verify that PRV rating conforms to boiler rating.	___	___	___	X	___	___	___	___
d. Boiler water treatment system functional.	___	___	X	X	___	___	___	___
e. Boiler startup and checkout complete.	___	___	X	X	___	___	___	___
f. Combustion efficiency demonstrated.	___	___	X	___	X	___	___	___
Electrical								
a. Verify that power disconnect is located within sight of the unit served.	___	___	___	X	___	___	___	___

Controls

a. Hot water pump interlock installed.	___	___	___	X	___	___	___	___
b. Hot water pump interlock tested.	___	___	___	X	___	___	___	___
c. Hot water heating system balanced.	___	___	X	X	___	___	___	___
d. Hot water heating controls operational.	___	___	X	X	___	___	___	___



Pre-commissioning Checklist - Fan Coil Unit, Reproduce these checklists and label individually for each of the fan coil units in this project and submit for approval.

For Fan Coil Unit: \_\_\_\_\_

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Vibration isolation devices installed.	___	___	X	X	X	___	___	___
b. Access doors/removable panels are operable and sealed.	___	___	X	___	X	___	___	___
c. Casing undamaged.	___	___	X	X	X	___	___	___
d. Insulation undamaged.	___	___	X	X	X	___	___	___
e. Condensate drainage is unobstructed.	___	___	X	X	X	___	___	___
f. Fan belt adjusted.	___	___	X	___	X	___	___	___
g. Any damage to coil fins has been repaired.	___	___	X	___	X	___	___	___
h. Manufacturer's required maintenance clearance provided.	___	___	X	X	X	___	___	___
Electrical								
a. Power available to unit disconnect.	___	___	___	X	___	___	___	___
b. Power available to unit control panel.	___	___	___	X	___	___	___	___
c. Proper motor rotation verified.	___	___	___	___	X	___	___	___
d. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___	___	___
a. Chilled water piping properly connected.	___	___	X	X	X	___	___	___
b. Chilled water piping pressure tested.	___	___	X	X	X	___	___	___
c. Hot water piping properly connected.	___	___	X	___	___	___	___	___
d. Hot water piping pressure tested.	___	___	X	___	___	___	___	___
Controls								
a. Control valves/actuators properly installed.	___	___	X	___	___	___	___	___
b. Control valves/actuators operable.	___	___	X	X	___	___	___	___
c. Verify proper location and installation	___	___	___	___	___	___	___	___

of thermostat.

\_\_\_ \_\_\_ X \_\_\_ \_\_\_ \_\_\_ \_\_\_ \_\_\_

Testing, Adjusting, and Balancing (TAB)

a. Construction filters removed and replaced.

\_\_\_ \_\_\_ X \_\_\_ \_\_\_ \_\_\_ \_\_\_ \_\_\_

b. TAB results +10%/-0% of L/s  
shown on drawings

c. TAB Report submitted.

\_\_\_ \_\_\_ X \_\_\_ X \_\_\_ \_\_\_ \_\_\_

Pre-commissioning Checklist - Unit Heater, Reproduce these checklists and label individually for each of the unit heaters in this project and submit for approval.

For Unit Heater: \_\_\_\_\_

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Hot water piping properly connected.	___	___	X	___	___	___	___	___
b. Hot water piping pressure tested.	___	___	X	___	___	___	___	___
c. Air vent installed on hot water coil with shutoff valve as specified.	___	___	X	X	X	___	___	___
d. Any damage to coil fins has been repaired.	___	___	X	___	X	___	___	___
e. Manufacturer's required maintenance/operational clearance provided.	___	___	X	X	X	___	___	___
Electrical								
a. Power available to unit disconnect.	___	___	___	X	___	___	___	___
b. Proper motor rotation verified.	___	___	___	X	X	___	___	___
c. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___	___	___
d. Power available to electric heating coil.	___	___	___	X	___	___	___	___
Controls								
a. Control valves properly installed.	___	___	X	___	___	___	___	___
b. Control valves operable.	___	___	X	X	___	___	___	___
c. Verify proper location and installation of thermostat.	___	___	X	___	___	___	___	___
Testing, Adjusting, and Balancing (TAB)								
a. TAB Report submitted.	___	___	X	___	X	___	___	___

Pre-commissioning Checklist - Exhaust Fan, Reproduce these checklists and label individually for each of the exhaust fans in this project and submit for approval.

For Exhaust Fan: \_\_\_\_\_

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Fan belt adjusted.	___	___	X	___	X	___	___	___
Electrical								
a. Power available to fan disconnect.	___	___	___	X	___	___	___	___
b. Proper motor rotation verified.	___	___	___	___	X	___	___	___
c. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___	___	___
Controls								
a. Control interlocks properly installed.	___	___	___	X	___	___	___	___
b. Control interlocks operable.	___	___	___	X	___	___	___	___
c. Dampers/actuators properly installed.	___	___	X	___	___	___	___	___
d. Dampers/actuators operable.	___	___	X	___	___	___	___	___
e. Verify proper location and installation of thermostat.	___	___	X	___	___	___	___	___
Testing, Adjusting, and Balancing (TAB)								
a. TAB results +10%/-0% to L/s shown on drawings	___	___	X	___	X	___	___	___
b. TAB Report submitted.	___	___	X	___	X	___	___	___

## Pre-commissioning Checklist - Supply Fan

For Supply Fan: 4-SF-1

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Fan belt adjusted.	___	___	X	___	X	___	___	___
Electrical								
a. Power available to fan disconnect.	___	___	___	X	___	___	___	___
b. Proper motor rotation verified.	___	___	___	___	X	___	___	___
c. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___	___	___
Controls								
a. Control interlocks properly installed.	___	___	___	X	___	___	___	___
b. Control interlocks operable.	___	___	___	X	___	___	___	___
c. Dampers/actuators properly installed.	___	___	X	___	___	___	___	___
d. Dampers/actuators operable.	___	___	X	___	___	___	___	___
e. Verify proper location and installation of thermostat.	___	___	X	___	___	___	___	___
Testing, Adjusting, and Balancing (TAB)								
a. TAB results +10%/-0% to L/s shown on drawings	___	___	X	___	X	___	___	___
b. TAB Report submitted.	___	___	X	___	X	___	___	___

Pre-commissioning Checklist - Domestic Water Heater, Reproduce these checklists and label individually for each of the exhaust fans in this project and submit for approval.

For Water Heater: \_\_\_\_\_

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Fan belt adjusted.	___	___	X	___	X	___	___	___
Electrical								
a. Power available to fan disconnect.	___	___	___	X	___	___	___	___
b. Proper motor rotation verified.	___	___	___	___	X	___	___	___
c. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___	___	___
Controls								
a. Control interlocks properly installed.	___	___	___	X	___	___	___	___
b. Control interlocks operable.	___	___	___	X	___	___	___	___
c. Dampers/actuators properly installed.	___	___	X	___	___	___	___	___
d. Dampers/actuators operable.	___	___	X	___	___	___	___	___
e. Verify proper location and installation of thermostat.	___	___	X	___	___	___	___	___
Testing, Adjusting, and Balancing (TAB)								
a. TAB results +10%/-0% to L/s shown on drawings	___	___	X	___	X	___	___	___
b. TAB Report submitted.	___	___	X	___	X	___	___	___

Pre-commissioning Checklist - HVAC System Controls, Reproduce these checklists and label individually for each of the HVAC control systems in this project and submit for approval.

For HVAC System: \_\_\_\_\_

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. As-built shop drawings submitted.	___	___	X	X	___	___	___	___
b. Layout of control panel matches drawings.	___	___	X	X	___	___	___	___
c. Framed instructions mounted in or near control panel.	___	___	X	X	___	___	___	___
d. Components properly labeled (on inside and outside of panel).	___	___	X	X	___	___	___	___
e. Control components piped and/or wired to each labeled terminal strip.	___	___	X	X	___	___	___	___
f. EMCS connection made to each labeled terminal strip as shown.	___	___	X	X	___	___	___	___
g. Control wiring and tubing labeled at all terminations, splices, and junctions.	___	___	X	X	___	___	___	___
h. Shielded wiring used on electronic sensors.	___	___	X	X	___	___	___	___
i. Air dryer installed as specified.	___	___	X	X	___	___	___	___
j. Water drain installed as specified.	___	___	X	X	___	___	___	___
Main Power and Control Air								
a. 110 volt AC power available to panel.	___	___	___	X	___	___	___	___
b. 138 kPa guage (20 psig) compressed air available to panel.	___	___	X	X	___	___	___	___
Testing, Commissioning, and Balancing								
a. Testing, Commissioning, and Balancing Report submitted.	___	___	X	___	___	___	___	___

APPENDIX B

FUNCTIONAL PERFORMANCE TESTS CHECKLISTS



Functional Performance Test Checklist - Pumps, Reproduce these checklists and label individually for each of the pumps in this project and submit for approval.

For Pump: \_\_\_\_\_

Prior to performing this checklist, ensure that for closed loop systems, system is pressurized and the make-up water system is operational or, for open loop systems, that the sumps are filled to the proper level.

1. Activate pump start using control system commands (all possible combination, on/auto, etc.). ON \_\_\_\_\_ AUTO \_\_\_\_\_  
OFF \_\_\_\_\_

a. Verify pressure drop across strainer:

Strainer inlet pressure \_\_\_\_\_ kPa (\_\_\_\_ psig)  
Strainer outlet pressure \_\_\_\_\_ kPa (\_\_\_\_ psig)

b. Verify pump inlet/outlet pressure reading, compare to Testing, Adjusting, and Balancing (TAB) Report, pump design conditions, and pump manufacturer's performance.

DESIGN	TAB	ACTUAL
Pump inlet pressure (kPa guage)	_____	_____
Pump outlet pressure (kPa gauge)	_____	_____

c. Operate pump at shutoff and at 100 percent of designed flow when all components are in full flow. Plot test readings on pump curve and compare results against readings taken from flow measuring devices.

	SHUTOFF	100 percent
Pump inlet pressure (kPa guage)	_____	_____
Pump outlet pressure	_____	_____
Pump flow rate (L/s)	_____	_____

d. Operate pump at shutoff and at minimum flow or when all components are in full by-pass. Plot test readings on pump curve and compare results against readings taken from flow measuring devices.

	SHUTOFF	100 percent
Pump inlet pressure (kPa guage)	_____	_____
Pump outlet pressure	_____	_____
Pump flow rate (L/s)	_____	_____

2. Verify motor amperage each phase and voltage phase to phase and phase to ground for both the full flow and the minimum flow conditions.

a. Full flow:

	PHASE 1	PHASE 2	PHASE 3
Amperage	_____	_____	_____
Voltage	_____	_____	_____
Voltage	_____	_____	_____
Voltage to ground	_____	_____	_____

b. Minimum flow:

	PHASE 1	PHASE 2	PHASE 3
Amperage	_____	_____	_____
Voltage	_____	_____	_____
Voltage	_____	_____	_____
Voltage to ground	_____	_____	_____

3. Unusual vibration, noise, etc.

\_\_\_\_\_

\_\_\_\_\_

4. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Chief Quality Control Representative

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Contractor's Mechanical Representative

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Contractor's Electrical Representative

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Contractor's Testing, Adjusting and Balancing

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Representative

Contractor's Controls Representative

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Contracting Officer's Representative

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Using Agency's Representative

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Functional Performance Test Checklist - Single Zone Air Handling Unit,  
Reproduce these checklists and label individually for each of the single zone  
air handlers in this project and submit for approval.

For Air Handling Unit: \_\_\_\_\_

1. Functional Performance Test: Contractor shall verify operation of air  
handling unit as per specification including the following:

a. The following shall be verified when the supply fan operating mode is  
initiated:

(1) All dampers in normal position. \_\_\_\_\_

(2) All valves in normal position. \_\_\_\_\_

(3) System safeties allow start if safety conditions are met. \_\_\_\_\_

b. Occupied mode of operation - economizer de-energized.

(1) Outside air damper at minimum position. \_\_\_\_\_

(2) Return air damper open. \_\_\_\_\_

(3) Relief air damper at minimum position. \_\_\_\_\_

(4) Chilled water control valve modulating to maintain space  
cooling temperature set point. \_\_\_\_\_

(5) Hot water control valve modulating to maintain space heating  
temperature set point input from outside air temperature controller. \_\_\_\_\_

c. Occupied mode of operation - economizer energized.

(1) Outside air damper modulated to maintain mixed air temperature  
set point. \_\_\_\_\_

(2) Relief air damper modulates with outside air damper according  
to sequence of operation. \_\_\_\_\_

(3) Chilled water control valve modulating to maintain space  
cooling temperature set point. \_\_\_\_\_

d. Unoccupied mode of operation

(1) All dampers in normal position. \_\_\_\_\_

(2) Verify low limit space temperature is maintained as specified  
in sequence of operation. \_\_\_\_\_

e. The following shall be verified when the supply fan off mode is  
initiated:

(1) All dampers in normal position. \_\_\_\_\_

(2) All valves in normal position. \_\_\_\_\_

(3) Fan de-energizes. \_\_\_\_\_

f. Verify cooling coil and heating coil operation by varying thermostat set point from cooling set point to heating set point and returning to cooling set point. \_\_\_\_\_

g. Verify safety shut down initiated by smoke detectors. \_\_\_\_\_

h. Verify safety shut down initiated by low temperature protection thermostat. \_\_\_\_\_

2. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Chief Quality Control Representative

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Contractor's Mechanical Representative

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Contractor's Electrical Representative

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Contractor's Testing, Adjusting and Balancing

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Representative

Contractor's Controls Representative

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Contracting Officer's Representative

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Using Agency's Representative

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Functional Performance Test Checklist - Packaged Air Cooled Chiller, Reproduce these checklists and label individually for each of the chillers in this project and submit for approval.

For Chiller: \_\_\_\_\_

1. Functional Performance Test: Contractor shall demonstrate operation of chilled water system as per specifications including the following: Start building air handler to provide load for chiller. Activate controls system chiller start sequence as follows.

a. Start chilled water pump and establish chilled water flow. Verify chiller-chilled water proof-of-flow switch operation. \_\_\_\_\_

b. Verify control system energizes chiller start sequence. \_\_\_\_\_

c. Verify chiller senses chilled water temperature above set point and control system activates chiller start. \_\_\_\_\_

d. Verify functioning of "soft start" sequence. \_\_\_\_\_

e. Shut off air handling equipment to remove load on chilled water system. Verify chiller shutdown sequence is initiated and accomplished after load is removed. \_\_\_\_\_

f. Restart air handling equipment one minute after chiller shut down. Verify chiller restart sequence. \_\_\_\_\_

2. Verify chiller inlet/outlet pressure reading, compare to Testing, Adjusting, and Balancing (TAB) Report, chiller design conditions, and chiller manufacturer's performance data.

	DESIGN	TAB	ACTUAL
Chiller inlet pressure (kPa gauge)	_____	_____	_____

Chiller outlet pressure (kPa gauge)	_____	_____	_____
-------------------------------------	-------	-------	-------

3. Verify chiller amperage each phase and voltage phase-to-phase and phase-to-ground.

	PHASE 1	PHASE 2	PHASE 3
Amperage	_____	_____	_____
Voltage	_____	_____	_____
Voltage	_____	_____	_____
Voltage to ground	_____	_____	_____

4. Record the following information:

Ambient dry bulb temperature \_\_\_\_\_ degrees C  
 Ambient wet bulb temperature \_\_\_\_\_ degrees C  
 Entering chilled water temperature \_\_\_\_\_ degrees C  
 Leaving chilled water temperature \_\_\_\_\_ degrees C

5. Unusual vibration, noise, etc.

---

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6. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Chief Quality Control Representative

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Contractor's Mechanical Representative

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Contractor's Electrical Representative

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Contractor's Testing, Adjusting and Balancing  
Representative

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Contractor's Controls Representative

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Contracting Officer's Representative

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Using Agency's Representative

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Functional Performance Test Checklist - Hot Water Boiler, Reproduce these checklists and label individually for each of the boilers in this project and submit for approval.

For Boiler: \_\_\_\_\_

1. Functional Performance Test: Contractor shall demonstrate operation of hot water system as per specifications including the following: Start building heating equipment to provide load for boiler. Activate controls system boiler start sequence as follows.

a. Start hot water pump and establish hot water flow. Verify boiler hot water proof-of-flow switch operation. \_\_\_\_\_

b. Verify control system energizes boiler start sequence. \_\_\_\_\_

c. Verify boiler senses hot water temperature below set point and control system activates boiler start. \_\_\_\_\_

d. Shut off building heating equipment to remove load on hot water system. Verify boiler shutdown sequence is initiated and accomplished after load is removed. \_\_\_\_\_

2. Verify boiler inlet/outlet pressure reading, compare to Test and Balance (TAB) Report, boiler design conditions, and boiler manufacturer's performance data.

	DESIGN	TAB	ACTUAL
Boiler inlet pressure (kPa gauge)	_____	_____	_____
Boiler outlet pressure (kPa gauge)	_____	_____	_____
Boiler flow rate (L/s)	_____	_____	_____
Flue-gas temperature at boiler outlet	_____	_____	_____
Percent carbon dioxide in flue-gas	_____	_____	_____
Draft at boiler flue-gas exit	_____	_____	_____
Draft or pressure in furnace	_____	_____	_____
Stack emission pollutants concentration	_____	_____	_____
Fuel type	_____	_____	_____
Combustion efficiency	_____	_____	_____

3. Record the following information:

Ambient temperature	_____	degrees C
Entering hot water temperature	_____	degrees C
Leaving hot water temperature	_____	degrees C

4. Verify temperatures in item 3 are in accordance with the reset schedule. \_\_\_\_\_

5. Verify proper operation of boiler safeties. \_\_\_\_\_

6. Unusual vibration, noise, etc.

\_\_\_\_\_

\_\_\_\_\_

7. Visually check refractory for cracks or spalling and refractory and tubes for flame impingement. \_\_\_\_\_

8. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Chief Quality Control Representative

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Contractor's Mechanical Representative

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Contractor's Electrical Representative

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Contractor's Testing, Adjusting and Balancing

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Representative

Contractor's Controls Representative

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Contracting Officer's Representative

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Using Agency's Representative

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Functional Performance Test Checklist - Fan Coil Units, Reproduce these checklists and label individually for fan coils in this project and submit for approval.

The Contracting Officer will select fan coil units to be spot-checked during the functional performance test. The number of terminals shall be 4 fan coil units per floor for each building.

For Fan Coil Unit: \_\_\_\_\_

1. Functional Performance Test: Contractor shall demonstrate operation of selected fan coils as per specifications including the following:

a. Cooling only fan coils:

(1) Verify fan coil unit response to room temperature set point adjustment. Changes to be cooling set point to cooling set point minus 10 degrees and return to cooling set point. \_\_\_\_\_

(2) Check blower fan air flow. \_\_\_\_\_ L/s  
Check blower fan air flow.

(3) Check cooling coil water flow. \_\_\_\_\_ L/s  
Check cooling coil water flow.

(4) Verify proper operation of cooling water control valve. \_\_\_\_\_

b. Cooling/heating fan coils:

(1) Verify fan coil unit response to room temperature set point adjustment. Changes to be cooling set point to heating set point and return to cooling set point. \_\_\_\_\_

(2) Check blower fan air flow. \_\_\_\_\_ L/s  
Check blower fan air flow.

(3) Check cooling coil water flow. \_\_\_\_\_ L/s  
Check cooling coil water flow.

(4) Verify proper operation of cooling water control valve. \_\_\_\_\_

(5) Check cooling mode inlet air temperature. \_\_\_\_\_ degrees C  
Check cooling mode inlet air temperature.

(6) Check cooling mode outlet air temperature. \_\_\_\_\_ degrees C  
Check cooling mode outlet air temperature.

(7) Check heating coil water flow. \_\_\_\_\_ L/s  
Check heating coil water flow.

(8) Verify proper operation of heating water control valve. \_\_\_\_\_

(9) Check heating mode inlet air temperature. \_\_\_\_\_ degrees C  
Check heating mode inlet air temperature.

- (10) Check heating mode outlet air temperature. \_\_\_\_\_ degrees C  
Check heating mode outlet air temperature.

2. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Chief Quality Control Representative

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Contractor's Mechanical Representative

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Contractor's Electrical Representative

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Contractor's Testing, Adjusting and Balancing

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Representative

Contractor's Controls Representative

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Contracting Officer's Representative

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Using Agency's Representative

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Functional Performance Test Checklist - Unit Heaters, Reproduce these checklists and label individually for each of the unit heater in this project and submit for approval.

For Unit Heater: \_\_\_\_\_

1. Functional Performance Test: Contractor shall demonstrate operation of selected unit heaters as per specifications including the following:

a. Verify unit heater response to room temperature set point adjustment. Changes to be heating set point to heating set point minus 10 degrees and return to heating set point. \_\_\_\_\_

b. Check blower fan speed. \_\_\_\_\_ rpm

c. Check heating mode inlet air temperature. \_\_\_\_\_ degrees C  
Check heating mode inlet air temperature.

d. Check heating mode outlet air temperature. \_\_\_\_\_ degrees C  
Check heating mode outlet air temperature.

2. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Chief Quality Control Representative

\_\_\_\_\_

Contractor's Mechanical Representative

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Contractor's Electrical Representative

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Contractor's Testing, Adjusting and Balancing

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Representative

Contractor's Controls Representative

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Contracting Officer's Representative

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Using Agency's Representative

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Functional Performance Test Checklist - HVAC Controls, Reproduce these checklists and label individually for each of the control systems in this project and submit for approval.

For HVAC System: \_\_\_\_\_

1. Functional Performance Test: Contractor shall verify operation of HVAC controls by performing the following tests:

a. Verify that controller is maintaining the set point by manually measuring the controlled variable with a thermometer, sling psychrometer, inclined manometer, etc.

b. Verify sensor/controller combination by manually measuring the controlled medium. Take readings from control panel display and compare readings taken manually. Record all readings.

Sensor \_\_\_\_\_  
Manual measurement \_\_\_\_\_  
Panel reading value \_\_\_\_\_

c. Verify system stability by changing the controller set point as follows:

- (1) Air temperature - 10 degrees F
- (2) Water temperature - 10 degrees F
- (3) Static pressure - 10 percent of set point
- (4) Relative humidity - percent (RH)

The control system shall be observed for 10 minutes after the change in set point. Instability or excessive hunting will be unacceptable.

d. Verify interlock with other HVAC controls.

e. Verify interlock with fire alarm control panel.

f. Verify interlock with EMCS.

g. Change controller set point 10 percent with EMCS and verify correct response.

2. Verify that operation of control system conforms to that specified in the sequence of operation.

3. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Chief Quality Control Representative

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Contractor's Mechanical Representative

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Contractor's Electrical Representative

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Contractor's Testing, Adjusting and Balancing  
Representative

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Contractor's Controls Representative

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Contractor's Officer's Representative

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Using Agency's Representative

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## SECTION 16370

## ELECTRICAL DISTRIBUTION SYSTEM, AERIAL

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C29.1	(1988) Electrical Power Insulators - Test Methods
ANSI C29.2	(1992) Insulators - Wet-Process Porcelain and Toughened Glass - Suspension Type
ANSI C29.5	(1984; R 1991) Wet-Process Porcelain Insulators - Low- and Medium-Voltage Types
ANSI C29.6	(1984) Wet-Process Porcelain Insulators - High-Voltage Pin Type
ANSI O5.1	(1992) Specifications and Dimensions for Wood Poles

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123	(1989a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153	(1996) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM B 1	(1990) Hard-Drawn Copper Wire
ASTM B 8	(1993) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B 117	(1994) Operating Salt Spray (Fog) Testing Apparatus
ASTM D 1654	(1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environment

## INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS (IEEE)

IEEE C2	(1997) National Electrical Safety Code
IEEE C37.41	(1994) Design Tests for High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories

IEEE C62.1	(1989; R 1994) Surge Arresters for ac Power Circuits
IEEE C62.2	(1987; R 1994) Guide for the Application of Gapped Silicon-Carbide Surge Arresters for Alternating Current Systems
IEEE C62.11	(1993) IEEE Standard Metal-Oxide Surge Arresters for AC Power Circuits
IEEE Std 81	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1)
IEEE Std 100	(1992) IEEE Standard Dictionary of Electrical and Electronics Terms

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA HV 2	(1984; R 1991) Application Guide for Ceramic Suspension Insulators
NEMA LA 1	(1992) Surge Arresters
NEMA SG 2	(1993) High Voltage Fuses

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1996) National Electrical Code
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## UNDERWRITERS LABORATORIES (UL)

UL 467	(1993; Rev thru Aug 1996) Grounding and Bonding Equipment
UL 486A	(1991; Rev Oct 1991) Wire Connectors and Soldering Lugs for Use with Copper Conductors
UL 486B	(1991; Rev thru Oct 1996) Wire Connectors for Use with Aluminum Conductors

## 1.2 GENERAL REQUIREMENTS

## 1.2.1 Terminology

Terminology used in this specification is as defined in IEEE Std 100.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

## SD-01 Data

Manufacturer's Catalog; GA.

Catalog cuts, brochures, circulars, specifications, product data, and printed information in sufficient detail and scope to verify compliance with the requirements of the contract documents.

Material, Equipment, and Fixture Lists; FIO.

A complete itemized listing of equipment and materials proposed for incorporation into the work. Each entry shall include the item number, the quantity of items proposed, and the name of the manufacturer of the item.

## SD-04 Drawings

Electrical Distribution System; GA.

Detail drawings consisting of equipment drawings, illustrations, schedules, instructions, diagrams and other information necessary to define the installation and enable the Government to check conformity with the requirements of the contract drawings. Detail drawings shall as a minimum include:

- a. Conductors.
- b. Insulators.
- c. Surge arresters.

If departures from the contract drawings are deemed necessary by the Contractor, complete details of such departures shall be submitted with the detail drawings. Approved departures shall be made at no additional cost to the Government.

Detail drawings shall show how components are assembled, function together and how they will be installed on the project. Data and drawings for component parts of an item or system shall be coordinated and submitted as a unit. Data and drawings shall be coordinated and included in a single submission. Multiple submissions for the same equipment or system are not acceptable except where prior approval has been obtained from the Contracting Officer. In such cases, a list of data to be submitted later shall be included with the first submission. Detail drawings shall consist of the following:

- a. Detail drawings showing physical arrangement, construction details, connections, finishes, materials used in fabrication, provisions for conduit or busway entrance, access requirements for installation and maintenance, physical size, electrical characteristics, foundation and support details, and equipment weight. Drawings shall be drawn to scale and/or dimensioned. Optional items shall be clearly identified as included or excluded.
- b. Internal wiring diagrams of equipment showing wiring as actually provided for this project. External wiring connections shall be clearly identified.



#### As-Built Drawings; GA.

The as-built drawings shall be a record of the construction as installed. The drawings shall include the information shown on the contract drawings as well as deviations, modifications, and changes from the contract drawings, however minor. The as-built drawings shall be kept at the job site and updated daily. The as-built drawings shall be a full sized set of prints marked to reflect deviations, modifications, and changes. The as-built drawings shall be complete and show the location, dimensions, part identification, and other information. Additional sheets may be added. The as-built drawings shall be jointly inspected for accuracy and completeness by the Contractor's quality control representative and by the Contracting Officer prior to the submission of each monthly pay estimate. Upon completion of the work, the Contractor shall submit three full sized sets of the marked prints to the Contracting Officer for approval. If upon review, the as-built drawings are found to contain errors and/or omissions, they will be returned to the Contractor for correction. The Contractor shall correct and return the as-built drawings to the Contracting Officer for approval within ten calendar days from the time the drawings are returned to the Contractor.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

Devices and equipment shall be visually inspected by the Contractor when received and prior to acceptance from conveyance. Stored items shall be protected from the environment in accordance with the manufacturer's published instructions. Damaged items shall be replaced. Oil filled transformers and switches shall be stored in accordance with the manufacturer's requirements. Wood poles held in storage for more than 2 weeks shall be stored in accordance with ANSI O5.1. Handling of wood poles shall be in accordance with ANSI O5.1, except that pointed tools capable of producing indentations more than inch in depth shall not be used. Metal poles shall be handled and stored in accordance with the manufacturer's instructions.

#### 1.5 EXTRA MATERIALS

One additional spare fuse or fuse element for each furnished fuse or fuse element shall be delivered to the Contracting Officer when the electrical system is accepted. Two complete sets of all special tools required for maintenance shall be provided, complete with a suitable tool box. Special tools are those that only the manufacturer provides, for special purposes (to access compartments, or operate, adjust, or maintain special parts).

### 2 PRODUCTS

#### 2.1 GENERAL REQUIREMENTS

Products shall conform to the following requirements. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

#### 2.2 STANDARD PRODUCT

Material and equipment shall be the standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially

duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

## 2.3 NAMEPLATES

### 2.3.1 General

Each major component shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a nameplate securely attached to the equipment. Equipment containing liquid-dielectrics shall have the type of dielectric on the nameplate. Nameplates shall be made of noncorrosive metal. As a minimum, nameplates shall be provided for transformers, regulators, circuit breakers, capacitors, meters and switches.

## 2.4 CORROSION PROTECTION

### 2.4.1 Aluminum Materials

Aluminum shall not be used in contact with earth or concrete. Where aluminum conductors are connected to dissimilar metal, fittings conforming to UL 486B shall be used.

### 2.4.2 Ferrous Metal Materials

#### 2.4.2.1 Hardware

Ferrous metal hardware shall be hot-dip galvanized in accordance with ASTM A 153 and ASTM A 123.

#### 2.4.2.2 Equipment

Equipment and component items, including but not limited to transformers and ferrous metal luminaires not hot-dip galvanized or porcelain enamel finished, shall be provided with corrosion-resistant finishes which shall withstand 120 hours of exposure to the salt spray test specified in ASTM B 117 without loss of paint or release of adhesion of the paint primer coat to the metal surface in excess of 1.6 mm from the test mark. The described test mark and test evaluation shall be in accordance with ASTM D 1654 with a rating of not less than 7 in accordance with TABLE 1, (procedure A). Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill galvanized sheet steel shall be coated with a zinc rich paint conforming to the manufacturer's standard.

## 2.5 CONDUCTORS, CONNECTORS, AND SPLICES

### 2.5.1 Copper Conductors

Hard-drawn-copper conductors shall comply with ASTM B 1 and ASTM B 8 as appropriate for the conductor size.

### 2.5.2 Connectors and Splices

Connectors and splices shall be of copper alloys for copper conductors, aluminum alloys for aluminum-composition conductors, and a type designed to minimize galvanic corrosion for copper to aluminum-composition conductors. Aluminum-composition and aluminum-composition to copper shall comply with UL 486B, and copper-to-copper shall comply with UL 486A.

## 2.6 MEDIUM-VOLTAGE LINES

### 2.6.1 Bare Medium-Voltage Lines

Bare medium-voltage line conductors shall hard-drawn-copper, CU. Conductor types shall not be mixed on any project, unless specifically indicated. Conductors larger than No. 2 AWG shall be stranded.

## 2.7 INSULATORS

Insulators shall comply with NEMA HV 2 for general requirements. Suspension insulators shall be used at corners, angles, dead-ends, other areas where line insulators do not provide adequate strength, and as indicated. Mechanical strength of suspension insulators and hardware shall exceed the rated breaking strength of the attached conductors.

### 2.7.1 Medium-Voltage Line Insulators

Medium-voltage line insulators shall comply with ANSI C29.2, ANSI C29.5, and ANSI C29.6, and as applicable. Ratings shall not be lower than the ANSI classes indicated in TABLE I. Horizontal line-post insulators shall be used for armless construction and shall have the same mechanical and electrical ratings as vertical line-post insulators for the ANSI class indicated, but shall be modified to be suitable for horizontal installation. Where line-post insulators are used for angles greater than 15 degrees, clamp-top fittings shall be provided as well as for other locations shown. Conductor clamps for use with clamp-top, line-post insulators shall be hot-dip galvanized malleable iron for copper conductors and aluminum alloy for aluminum-composition conductors. Either line-post or pin insulators may be used for crossarm construction. Pin insulators for use on voltages in excess of 6 kV phase-to-phase shall be radio-interference-free or else line-post insulators shall be used.

TABLE I

MINIMUM ANSI RATING OF MEDIUM-VOLTAGE INSULATORS BY CLASS

Voltage Level	Line-Post	Pin	Suspension
Up to 5 kV	57-1 or 11	55-3	One 52-1
	57-1 or 11	55-5	Two 52-1
6 kV to 15 kV	57-1 or 11	55-5	Two 52-2
	57-2 or 12	56-3	Two 52-3 or 4

## 2.8 FUSES AND SWITCHES, MEDIUM-VOLTAGE

### 2.8.1 Fuse Cutouts

Medium-voltage fuses and cutouts shall comply with NEMA SG 2 and shall be of the loadbreak open type construction rated 15 kV and of the heavy-duty type. Open-link cut-outs are not acceptable. Fuses shall be either indicating or dropout type. Fuse ratings shall be as indicated. Fuse cutouts shall be equipped with mounting brackets suitable for the indicated installations.

## 2.9 SURGE ARRESTERS

Surge arresters shall comply with NEMA LA 1 and IEEE C62.1, IEEE C62.2, and IEEE C62.11, and shall be provided for protection of aerial-to-underground transitions and other indicated equipment. Arresters shall distribution class, rated as shown. Arresters shall be equipped with mounting brackets suitable for the indicated installations. Arresters shall be combination valve-metal-oxide varistor type suitable for outdoor installations.

## 2.10 GROUNDING AND BONDING

### 2.10.1 Driven Ground Rods

Ground rods shall be of copper-clad steel conforming to UL not less than 19.1 mm in diameter by 3.1 meter in length of the sectional type driven full length into the earth.

### 2.10.2 Grounding Conductors

Grounding conductors shall be bare, except where installed in conduit with associated phase conductors. Insulated conductors shall be of the same material as the phase conductors and green color-coded, except that conductors shall be rated no more than 600 volts. Bare conductors shall be ASTM B 8 soft-drawn unless otherwise indicated. Aluminum is not acceptable.

## 2.11 WARNING SIGNS

Warning signs shall be porcelain enameled steel or approved equal. Voltage warning signs shall comply with IEEE C2.

## 2.12 FACTORY TESTS

Factory tests shall be performed, as follows, in accordance with the applicable publications and with other requirements of these specifications. The Contracting Officer shall be notified at least 10 days before the equipment is ready for testing.

f. High-Voltage Fuses: Manufacturer's standard tests in accordance with IEEE C37.41.

g. Electric Power Insulators: Manufacturer's standard tests in accordance with ANSI C29.1.

## 3 EXECUTION

### 3.1 GENERAL INSTALLATION REQUIREMENTS

Equipment and devices shall be installed and energized in accordance with the manufacturer's published instructions. Circuits installed in conduits or underground and splices and terminations for medium-voltage cable shall conform to the requirements of Section 16375 ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND. Secondary circuits installed in conduit on poles shall conform to the requirements of Section 16415 ELECTRICAL WORK, INTERIOR.

### 3.1.1 Conformance to Codes

The installation shall comply with the requirements and recommendations of IEEE C2 for heavy loading districts, Grade B construction. No reduction in clearance shall be made. The installation shall also comply with the applicable parts of NFPA 70.

### 3.1.2 Verification of Dimensions

The Contractor shall become familiar with details of the work, shall verify dimensions in the field, and shall notify the Contracting Officer of any discrepancy before performing any work.

## 3.2 CONNECTIONS TO UTILITY LINES

The Contractor shall coordinate the work with the Contracting Officer and shall provide for final connections to the installation electric lines.

## 3.3 CONNECTIONS BETWEEN AERIAL AND UNDERGROUND SYSTEMS

Connections between aerial and underground systems shall be made as shown. Underground cables shall be extended up poles in conduit to cable terminations. Conduits shall be secured to poles by two-hole galvanized steel pipe straps spaced not more than 3 m apart and with one support not more than 300 mm from any bend or termination. Cables shall be supported by devices separate from the conduit or guard, near their point of exit from the riser conduit or guard. Risers shall be equipped with bushings to protect cables. Capnut potheads shall be used to terminate medium-voltage multiple-conductor cable.

## 3.4 CONNECTIONS TO BUILDINGS

### 3.4.1 Underground Services

Connections to buildings shall be made at the point indicated and shall be terminated at the service entrance equipment terminals. Cable pulling shall be in accordance with Section 16375, ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND. Service entrance conduits with termination fittings and conductors within the building shall conform to the requirements of Section 16415 ELECTRICAL WORK, INTERIOR.

## 3.5 GROUNDING

Noncurrent-carrying metal parts of equipment and conductor assemblies, such as luminaires, medium-voltage cable terminations and messengers, metal poles, operating mechanisms of pole top switches, panel enclosures, transformers, capacitors, recloser frames (cases) and other noncurrent-carrying metal items shall be grounded. Additional grounding of equipment, neutral, and surge arrester grounding systems shall be installed at poles where indicated.

### 3.5.1 Grounding Electrodes

Grounding electrodes shall be installed as follows:

- a. Driven rod electrodes - Unless otherwise indicated, ground rods shall be located approximately 900 mm out from base of the pole and shall be driven into the earth until the tops of the rods are approximately 300 mm below finished grade. Multiple rods shall be evenly spaced at least 3 m apart and connected together 600 mm below grade with a minimum No. 6 bare copper conductor.
- b. Ground Resistance - The maximum resistance of a driven ground rod shall not exceed 25 ohms under normally dry conditions. Whenever the required ground resistance is not met, provide additional electrodes interconnected with grounding conductors, to achieve the specified ground resistance. The additional electrodes will be up to three, 3 m rods spaced a minimum of 3 m apart. In high ground resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, the Contracting Officer shall be notified immediately. Connections below grade shall be fusion welded. Connections above grade shall be fusion welded or shall use UL 467 approved connectors.

### 3.5.2 Grounding and Bonding Connections

Connections above grade shall be made by the fusion-welding process or with bolted solderless connectors in compliance with UL 467, and those below grade shall be made by a fusion-welding process. Where grounding conductors are connected to aluminum-composition conductors, specially treated or lined copper-to-aluminum connectors suitable for this purpose shall be used.

### 3.5.3 Grounding Electrode Conductors

On multi-grounded circuits, as defined in IEEE C2, provide a single continuous vertical grounding electrode conductor. Neutrals, surge arresters, and equipment grounding conductors shall be bonded to this conductor. For single grounded or ungrounded systems, provide a grounding conductor for the surge arrester and equipment grounding conductors and a separate grounding conductor for the secondary neutrals. Grounding electrode conductors shall be sized as shown. Secondary system neutral conductors shall be connected directly to the transformer neutral bushings, then connected with a neutral bonding jumper between the transformer neutral bushing and the vertical grounding electrode conductor, as shown. Grounding electrode conductors shall be stapled to wood poles at intervals not exceeding 600 mm. On metal poles, a preformed galvanized steel strap, 15.9 mm wide by 0.853 minimum by length, secured by a preformed locking method standard with the manufacturer, shall be used to support a grounding electrode conductor installation on the pole and spaced at intervals not exceeding 1.5 m with one band not more than 75 mm from each end of the vertical grounding electrode conductor. Bends greater than 45 degrees in grounding electrode conductor are not permitted.

### 3.6 FIELD TESTING

#### 3.6.1 General

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer 10 days prior to conducting tests. The Contractor shall furnish materials, labor, and equipment necessary to conduct field tests. The Contractor shall perform tests and inspections recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor shall maintain a written record of tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results. Field reports will be signed and dated by the Contractor.

#### 3.6.2 Safety

The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor shall replace any devices or equipment which are damaged due to improper test procedures or handling.

#### 3.6.3 Ground-Resistance Tests

The resistance of each pole ground shall be measured using the fall-of-potential method defined in IEEE Std 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes shall be provided.

#### 3.6.4 Operating Tests

After the installation is completed, and at such time as the Contracting Officer may direct, the Contractor shall conduct operating tests for approval. The equipment shall be demonstrated to operate in accordance with the specified requirements. An operating test report shall be submitted in accordance with paragraph SUBMITTALS.

### 3.7 ACCEPTANCE

Final acceptance of the facility will not be given until the Contractor has successfully completed all tests and after all defects in installation, material or operation have been corrected.

## SECTION 16375

## ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1	(1995) Code for Electricity Metering
ANSI C12.4	(1984; R 1990) Mechanical Demand Registers
ANSI C12.10	(1987) Electromechanical Watthour Meters
ANSI C12.11	(1987; R 1993) Instrument Transformers for Revenue Metering, 10 kV BIL through 350 kV BIL (0.6 kV NSV through 69 kV NSV)
ANSI C29.1	(1988) Electrical Power Insulators - Test Methods
ANSI C37.16	(1988; C37.16a) Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors - Preferred Ratings, Related Requirements, and Application Recommendations
ANSI C37.46	(1981; R 1992) Power Fuses and Fuse Disconnecting Switches
ANSI C57.12.21	(1980) Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Single-Phase Distribution Transformers with High-Voltage Bushings; (High-Voltage, 34 500 Grd Y/19 920 Volts and Below; Low-Voltage, 240/120; 167 kVA and Smaller)
ANSI C57.12.26	(1993) Pad-Mounted Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers for Use with Separable Insulated High-Voltage Connectors, High-Voltage, 34 500 Grd Y/19 920 Volts and Below; 2500 kVa and Smaller
ANSI C80.1	(1990) Rigid Steel Conduit - Zinc Coated
ANSI C119.1	(1986) Sealed Insulated Underground Connector Systems Rated 600 Volts
ANSI O5.1	(1992) Specifications and Dimensions for Wood Poles



## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123	(1989a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153	(1996) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM B 8	(1993) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B 117	(1994) Operating Salt Spray (Fog) Testing Apparatus
ASTM D 923	(1991) Sampling Electrical Insulating Liquids
ASTM D 1654	(1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D 4059	(1991) Analysis of Polychlorinated Biphenyls in Insulating Liquids by Gas Chromatography
ASTM F 883	(1990) Padlocks

## ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

AEIC CS5	(1994) Specifications for Cross-linked Polyethylene Insulated Shielded Power Cables Rated 5 Through 46 kV
AEIC CS6	(1987; Rev Mar 1989) Ethylene Propylene Rubber Insulated Shielded Power Cables Rated 5 Through 69 kV

## FACTORY MUTUAL ENGINEERING AND RESEARCH (FM)

FM P7825	(1995; Supple I; Supple II; Supple III) Approval Guide
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## INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(1997) National Electrical Safety Code
IEEE C37.13	(1990) Low-Voltage AC Power Circuit Breakers Used in Enclosures
IEEE C57.12.00	(1993) IEEE Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.13	(1993) Instrument Transformers
IEEE C57.98	(1993) Guide for Transformer Impulse Tests
IEEE C62.1	(1989; R 1994) Surge Arresters for ac Power Circuits

IEEE C62.2	(1987; R 1994) Guide for the Application of Gapped Silicon-Carbide Surge Arresters for Alternating Current Systems
IEEE C62.11	(1993) IEEE Standard Metal-Oxide Surge Arresters for AC Power Circuits
IEEE Std 48	(1996) Standard Test Procedures and Requirements for Alternating-Current Cable Terminations 2.5 kV through 765 kV
IEEE Std 81	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1)
IEEE Std 100	(1992) IEEE Standard Dictionary of Electrical and Electronics Terms
IEEE Std 386	(1995) Separable Insulated Connector Systems for Power Distribution Systems Above 600V
IEEE Std 404	(1993) Cable Joints for Use with Extruded Dielectric Cable Rated 5000 V through 46 000 V and Cable Joints for Use with Laminated Dielectric Cable Rated 2500 V Through 500 000 V
IEEE Std 592	(1990) Exposed Semiconducting Shields on Premolded High Voltage Cable Joints and Separable Insulated Connectors

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA AB 1	(1993) Molded Case Circuit Breakers and Molded Case Switches
NEMA FB 1	(1993) Fittings, Cast Metal Boxes and Conduit Bodies for Conduit and Cable Assemblies
NEMA FU 1	(1986) Low Voltage Cartridge Fuses
NEMA LA 1	(1992) Surge Arresters
NEMA SG 3	(1990) Low-Voltage Power Circuit Breakers
NEMA TC 5	(1990) Corrugated Polyolefin Coilable Plastic Utilities Duct
NEMA TC 6	(1990) PVC and ABS Plastic Utilities Duct for Underground Installation
NEMA TC 7	(1990) Smooth-Wall Coilable Polyethylene Electrical Plastic Duct

NEMA WC 7 (1993) Cross-Linked-Thermosetting-Polyethylene- Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

NEMA WC 8 (1993) Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (1996) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 6 (1993; Rev March 96) Rigid Metal Conduit

UL 198C (1986; Rev thru Jun 1993) High-Interrupting-Capacity Fuses, Current-Limiting Types

UL 198D (1995) Class K Fuses

UL 198E (1988; Rev Jul 1988) Class R Fuses

UL 198H (1988; Rev thru Nov 1993) Class T Fuses

UL 467 (1993; Rev thru Aug 1996) Grounding and Bonding Equipment

UL 486A (1991; Rev Oct 1991) Wire Connectors and Soldering Lugs for Use with Copper Conductors

UL 486B (1991; Rev thru Oct 1996) Wire Connectors for Use with Aluminum Conductors

UL 489 (1996) Molded-Case Circuit Breakers and Circuit-Breaker Enclosures

UL 510 (1994) Insulating Tape

UL 514A (1996) Metallic Outlet Boxes

UL 651 (1995) Schedule 40 and 80 Rigid PVC Conduit

UL 854 (1996; Rev May 1996) Service-Entrance Cables

UL 1242 (1996) Intermediate Metal Conduit

1.2 GENERAL REQUIREMENTS

1.2.1 Terminology

Terminology used in this specification is as defined in IEEE Std 100.

### 1.3 SUBMITTALS

Governmental approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

#### SD-01 Data

Fault Current and Protective Devices Coordination Studies; GA.

The study shall be submitted with protective device equipment submittals. Not time extension or similar contract modifications will be granted for work arising out of the requirements for this study. Approval of protective devices proposed shall be based on recommendations of this study. The Government shall not be held responsible for any changes to equipment, device ratings, settings, or additional labor for installation of equipment or devices ordered and/or procured prior to approval of the study.

Manufacturer's Catalog Data; GA.

Catalog cuts, brochures, circulars, specifications, product data, and printed information in sufficient detail and scope to verify compliance with the requirements of the contract documents.

Material, Equipment, and Fixture Lists; FIO.

A complete itemized listing of equipment and materials proposed for incorporation into the work. Each entry shall include an item number, the quantity of items proposed, and the name of the manufacturer of each such item.

Installation Procedures; FIO.

As a minimum, installation procedures for transformers, substations, switchgear, and medium-voltage cable terminations and splices.

Procedures shall include cable pulling plans, diagrams, instructions, and precautions required to install, adjust, calibrate, and test the devices and equipment.

#### SD-04 Drawings

Electrical Distribution System; GA.

Detail drawings consisting of equipment drawings, illustrations, schedules, instructions, diagrams manufacturers standard installation drawings and other information necessary to define the installation and enable the Government to check conformity with the requirements of the contract drawings.

If departures from the contract drawings are deemed necessary by the Contractor, complete details of such departures shall be included with the detail drawings. Approved departures shall be made at no additional cost to the Government.

Detail drawings shall show how components are assembled, function together and how they will be installed on the project. Data and drawings for component parts of an item or system shall be coordinated and submitted as a unit. Data and drawings shall be coordinated and included in a single submission. Multiple submissions for the same equipment or system are not acceptable except where prior approval has been obtained from the Contracting Officer. In such cases, a list of data to be submitted later shall be included with the first submission. Detail drawings shall consist of the following:

- a. Detail drawings showing physical arrangement, construction details, connections, finishes, materials used in fabrication, provisions for conduit or busway entrance, access requirements for installation and maintenance, physical size, electrical characteristics, foundation and support details, and equipment weight. Drawings shall be drawn to scale and/or dimensioned. All optional items shall be clearly identified as included or excluded.
- b. Internal wiring diagrams of equipment showing wiring as actually provided for this project. External wiring connections shall be clearly identified.

Detail drawings shall as a minimum depict the installation of the following items:

- a. Medium-voltage cables and accessories including cable installation plan.
- b. Transformers.
- g. Surge arresters.

#### As-Built Drawings; GA.

The as-built drawings shall be a record of the construction as installed. The drawings shall include the information shown on the contract drawings as well as deviations, modifications, and changes from the contract drawings, however minor. The as-built drawings shall be a full sized set of prints marked to reflect deviations, modifications, and changes. The as-built drawings shall be complete and show the location, size, dimensions, part identification, and other information. Additional sheets may be added. The as-built drawings shall be jointly inspected for accuracy and completeness by the Contractor's quality control representative and by the Contracting Officer prior to the submission of each monthly pay estimate. Upon completion of the work, the Contractor shall provide three full sized sets of the marked prints to the Contracting Officer for approval. If upon review, the as-built drawings are found to contain errors and/or omissions, they will be returned to the Contractor for correction. The Contractor shall correct and return the as-built drawings to the Contracting Officer for approval within 10 calendar days from the time the drawings are returned to the Contractor.

## SD-09 Reports

## Factory Test; FIO.

Certified factory test reports shall be submitted when the manufacturer performs routine factory tests, including tests required by standards listed in paragraph REFERENCES. Results of factory tests performed shall be certified by the manufacturer, or an approved testing laboratory, and submitted within 7 days following successful completion of the tests. The manufacturer's pass-fail criteria for tests specified in paragraph FIELD TESTING shall be included.

## Field Testing; GA.

A proposed field test plan, 20 days prior to testing the installed system. No field test shall be performed until the test plan is approved. The test plan shall consist of complete field test procedures including tests to be performed, test equipment required, and tolerance limits.

## Test Reports; GA.

Six copies of the information described below in 215.9 by 279.4 mm (8-1/2 by 11 inch) binders having a minimum of three rings, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

- a. A list of equipment used, with calibration certifications.
- b. A copy of measurements taken.
- c. The dates of testing.
- d. The equipment and values to be verified.
- e. The condition specified for the test.
- f. The test results, signed and dated.
- g. A description of adjustments made.

## Cable Installation Reports; GA.

Six copies of the information described below in 215.9 by 279.4 mm (8-1/2 by 11 inch) binders having a minimum of three rings from which material may readily be removed and replaced, including a separate section for each cable pull. Sections shall be separated by heavy plastic dividers with tabs, with all data sheets signed and dated by the person supervising the pull.

- a. Site layout drawing with cable pulls numerically identified.
- b. A list of equipment used, with calibration certifications. The manufacturer and quantity of lubricant used on pull.
- c. The cable manufacturer and type of cable.
- d. The dates of cable pulls, time of day, and ambient temperature.

- e. The length of cable pull and calculated cable pulling tensions.
- f. The actual cable pulling tensions encountered during pull.

#### SD-13 Certificates

##### Materials and Equipment; GA.

Where materials or equipment are specified to conform to the standards of the Underwriters Laboratories (UL) or to be constructed or tested, or both, in accordance with the standards of the American National Standards Institute (ANSI), the Institute of Electrical and Electronics Engineers (IEEE), or the National Electrical Manufacturers Association (NEMA), the Contractor shall submit proof that the items provided conform to such requirements. The label of, or listing by, UL will be acceptable as evidence that the items conform. Either a certification or a published catalog specification data statement, to the effect that the item is in accordance with the referenced ANSI or IEEE standard, will be acceptable as evidence that the item conforms. A similar certification or published catalog specification data statement to the effect that the item is in accordance with the referenced NEMA standard, by a company listed as a member company of NEMA, will be acceptable as evidence that the item conforms. In lieu of such certification or published data, the Contractor may submit a certificate from a recognized testing agency equipped and competent to perform such services, stating that the items have been tested and that they conform to the requirements listed, including methods of testing of the specified agencies. Compliance with above-named requirements does not relieve the Contractor from compliance with any other requirements of the specifications.

##### Cable Splicer Qualification; FIO.

A certification that contains the names and the qualifications of people recommended to perform the splicing and termination of medium-voltage cables approved for installation under this contract. The certification shall indicate that any person recommended to perform actual splicing and terminations has been adequately trained in the proper techniques and have had at least three recent years of experience in splicing and terminating the same or similar types of cables approved for installation. In addition, any person recommended by the Contractor may be required to perform a practice splice and termination, in the presence of the Contracting Officer, before being approved as a qualified installer of medium-voltage cables. If that additional requirement is imposed, the Contractor shall provide short sections of the approved types of cables along with the approved type of splice and termination kits, and detailed manufacturer's instruction for the proper splicing and termination of the approved cable types.

##### Cable Installer Qualifications; FIO.

The Contractor shall provide at least one onsite person in a supervisory position with a documentable level of competency and experience to supervise all cable pulling operations. A resume shall be provided showing the cable installers' experience in the last three years, including a list of references complete with points of contact, addresses and telephone numbers.

## SD-19 OPERATION AND MAINTENANCE MANUALS

Electrical Distribution System; GA.

Six copies of operation and maintenance manuals, within 7 calendar days following the completion of tests and including assembly, installation, operation and maintenance instructions, spare parts data which provides supplier name, current cost, catalog order number, and a recommended list of spare parts to be stocked. Manuals shall also include data outlining detailed procedures for system startup and operation, and a troubleshooting guide which lists possible operational problems and corrective action to be taken. A brief description of all equipment, basic operating features, and routine maintenance requirements shall also be included. Documents shall be bound in a binder marked or identified on the spine and front cover. A table of contents page shall be included and marked with pertinent contract information and contents of the manual. Tabs shall be provided to separate different types of documents, such as catalog ordering information, drawings, instructions, and spare parts data. Index sheets shall be provided for each section of the manual when warranted by the quantity of documents included under separate tabs or dividers.

Three additional copies of the instructions manual shall be provided within 30 calendar days following the manuals.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

Devices and equipment shall be visually inspected by the Contractor when received and prior to acceptance from conveyance. Stored items shall be protected from the environment in accordance with the manufacturer's published instructions. Damaged items shall be replaced. Oil filled transformers and switches shall be stored in accordance with the manufacturer's requirements. Wood poles held in storage for more than 2 weeks shall be stored in accordance with ANSI O5.1. Handling of wood poles shall be in accordance with ANSI O5.1, except that pointed tools capable of producing indentations more than 25 mm in depth shall not be used. Metal poles shall be handled and stored in accordance with the manufacturer's instructions.

#### 1.5 EXTRA MATERIALS

One additional spare fuse or fuse element for each furnished fuse or fuse element shall be delivered to the contracting officer when the electrical system is accepted. Two complete sets of all special tools required for maintenance shall be provided, complete with a suitable tool box. Special tools are those that only the manufacturer provides, for special purposes (to access compartments, or operate, adjust, or maintain special parts).

### 2 PRODUCTS

#### 2.1 STANDARD PRODUCT

Material and equipment shall be the standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Items of the same classification shall be identical including equipment, assemblies, parts, and components.



## 2.2 NAMEPLATES

### 2.2.1 General

Each major component of this specification shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a nameplate securely attached to the equipment. Nameplates shall be made of noncorrosive metal. Equipment containing liquid dielectrics shall have the type of dielectric on the nameplate. Sectionalizer switch nameplates shall have a schematic with all switch positions shown and labeled. As a minimum, nameplates shall be provided for transformers, circuit breakers, meters, switches, and switchgear.

### 2.2.2 Liquid-Filled Transformer Nameplates

Power transformers shall be provided with nameplate information in accordance with IEEE C57.12.00. Nameplates shall indicate the number of liters and composition of liquid-dielectric, and shall be permanently marked with a statement that the transformer dielectric to be supplied is non-polychlorinated biphenyl. If transformer nameplate is not so marked, the Contractor shall furnish manufacturer's certification for each transformer that the dielectric is non-PCB classified, with less than 50 ppm PCB content in accordance with paragraph LIQUID DIELECTRICS. Certifications shall be related to serial numbers on transformer nameplates. Transformer dielectric exceeding the 50 ppm PCB content or transformers without certification will be considered as PCB insulated and will not be accepted.

## 2.3 CORROSION PROTECTION

### 2.3.1 Aluminum Materials

Aluminum shall not be used in contact with earth or concrete. Where aluminum conductors are connected to dissimilar metal, fittings conforming to UL 486B shall be used.

### 2.3.2 Ferrous Metal Materials

#### 2.3.2.1 Hardware

Ferrous metal hardware shall be hot-dip galvanized in accordance with ASTM A 153 and ASTM A 123.

#### 2.3.2.2 Equipment

Equipment and component items, including but not limited to transformer stations and ferrous metal luminaries not hot-dip galvanized or porcelain enamel finished, shall be provided with corrosion-resistant finishes which shall withstand 120 hours of exposure to the salt spray test specified in ASTM B 117 without loss of paint or release of adhesion of the paint primer coat to the metal surface in excess of 1.6 mm from the test mark. The scribed test mark and test evaluation shall be in accordance with ASTM D 1654 with a rating of not less than 7 in accordance with TABLE 1, (procedure A). Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill galvanized sheet steel shall be coated with a zinc rich paint conforming to the manufacturer's standard.

### 2.3.3 Finishing

Painting required for surfaces not otherwise specified and finish painting of items only primed at the factory shall be as specified in Section 09900 PAINTING, GENERAL.

## 2.4 CABLES

Cables shall be single conductor type unless otherwise indicated.

### 2.4.1 Conductor Material

Underground cables shall be of soft drawn conductor material.

### 2.4.2 Medium-Voltage Cables

#### 2.4.2.1 General

Medium voltage cables shall conform to the requirements of NEMA WC 7 for cables utilizing cross-linked thermosetting polyethylene ((XLP) insulation and NEMA WC 8 for cables utilizing ethylene-propylene-rubber (EPR) insulation. Cables shall be in accordance with the requirements of NFPA 70.

#### 2.4.2.2 Insulation

Cables shall utilize cross-linked thermosetting polyethylene (XLP) insulation or ethylene-propylene-rubber (EPR) insulation. Cables shall be provided with 133 percent insulation level except that 28 kV and 35 kV rated cable insulation thicknesses shall be in accordance with AEIC CS5 or AEIC CS6 as applicable.

#### 2.4.2.3 Jackets

Cables shall be provided with a nonmetallic jacket. Concentric neutral cables for direct buried applications shall have a moisture-resistant, nonmetallic jacket rated for direct burial.

#### 2.4.2.4 Neutrals

Neutral conductors of grounded neutral systems except for concentric neutral cables shall be of the same insulation material as phase conductors, except that a 600-volt insulation rating is acceptable.

#### 2.4.2.5 Shielding

Cables rated for above 2 kV shall have both conductor and insulation shielding for each phase, except insulation shielding is not required for 5 kV armored or metallic-sheathed cable.

#### 2.4.2.6 Ratings

Medium-voltage cables shall be rated for a circuit voltage of 15 kV.

### 2.4.3 Low-Voltage Cables

Cables shall be rated 600 volts and shall conform to the requirements of NFPA 70. Cables shall utilize cross-linked thermosetting polyethylene (XLP)

insulation and shall conform to the requirements of NEMA WC 7 or ethylene-propylene-rubber (EPR) insulation and shall conform to the requirements of NEMA WC 8.

#### 2.4.3.1 Direct Buried

Service entrance cables shall conform to UL 854 for Type USE service entrance cable. Other direct buried cable applications shall be single-conductor cable identified for such use and conforming to NEMA WC 7 or NEMA WC 8.

#### 2.4.3.2 In Duct

Cables shall be single-conductor cable, Type RHW, THW, THWN, TW, USE, or XHHW in accordance with NFPA 70. Cables in factory-installed, coilable-plastic-duct assemblies shall conform to NEMA TC 5 or NEMA TC 7.

### 2.5 CABLE JOINTS, TERMINATIONS, AND CONNECTORS

#### 2.5.1 Medium-Voltage Cable Joints

Medium-voltage cable joints shall comply with IEEE Std 404 and IEEE Std 592. Medium-voltage cable terminations shall comply with IEEE Std 48. Joints shall be the standard products of a manufacturer and shall be either of the factory preformed type or of the kit type containing tapes and other required parts. Joints shall have ratings not less than the ratings of the cables on which they are installed. Splice kits may be of the heat-shrinkable type for voltages up to 15 kV, of the premolded splice and connector type, the conventional taped type, or the resin pressure-filled overcast taped type for voltages up to 35 kV; except that for voltages of 7.5 kV or less a resin pressure-filled type utilizing a plastic-tape mold is acceptable. Joints used in manholes, handholes, vaults and pull boxes shall be certified by the manufacturer for waterproof, submersible applications.

#### 2.5.2 Medium-Voltage Separable Insulated Connectors

Separable insulated connectors shall comply with IEEE Std 386 and IEEE Std 592 and shall be of suitable construction or standard splice kits shall be used. Separable insulated connectors are acceptable for voltages up to 35 kV. Connectors shall be of the loadbreak type as indicated, of suitable construction for the application and the type of cable connected, and shall include cable shield adaptors. Separable insulated connectors shall not be used as substitutes for conventional permanent splices. External clamping points and test points shall be provided.

#### 2.5.3 Low-Voltage Cable Splices

Low-voltage cable splices and terminations shall be rated at not less than 600 Volts. Splices in conductors No. 10 AWG and smaller shall be made with an insulated, solderless, pressure type connector, conforming to the applicable requirements of UL 486A. Splices in conductors No. 8 AWG and larger shall be made with noninsulated, solderless, pressure type connector, conforming to the applicable requirements of UL 486A and UL 486B. Splices shall then be covered with an insulation and jacket material equivalent to the conductor insulation and jacket. Splices below grade or in wet locations shall be sealed type conforming to ANSI C119.1 or shall be waterproofed by a sealant-filled, thick wall, heat shrinkable, thermosetting

tubing or by pouring a thermosetting resin into a mold that surrounds the joined conductors.

#### 2.5.4 Terminations

Terminations shall be in accordance with IEEE Std 48, Class 1 or Class 2; of the molded elastomer, wet-process porcelain, prestretched elastomer, heat-shrinkable elastomer, or taped type. Acceptable elastomers are track-resistant silicone rubber or track-resistant ethylene propylene compounds, such as ethylene propylene rubber or ethylene propylene diene monomer. Separable insulated connectors may be used for apparatus terminations, when such apparatus is provided with suitable bushings. Terminations shall be of the outdoor type, except that where installed inside outdoor equipment housings which are sealed against normal infiltration of moisture and outside air, indoor, Class 2 terminations are acceptable. Class 3 terminations are not acceptable. Terminations, where required, shall be provided with mounting brackets suitable for the intended installation and with grounding provisions for the cable shielding, metallic sheath, and armor.

##### 2.5.4.1 Factory Preformed Type

Molded elastomer, wet-process porcelain, prestretched, and heat-shrinkable terminations shall utilize factory preformed components to the maximum extent practicable rather than tape build-up. Terminations shall have basic impulse levels as required for the system voltage level.

##### 2.5.4.2 Taped Terminations

Taped terminations shall use standard termination kits providing terminal connectors, field-fabricated stress cones, and rain hoods. Terminations shall be at least 510 long from the end of the tapered cable jacket to the start of the terminal connector, or not less than the kit manufacturer's recommendations, whichever is greater.

#### 2.6 CONDUIT AND DUCTS

Ducts shall be single, round-bore type, with wall thickness and fittings suitable for the application

##### 2.6.1 Metallic Conduit

Intermediate metal conduit shall comply with UL 1242. Rigid galvanized steel conduit shall comply with UL 6 and ANSI C80.1. Metallic conduit fittings and outlets shall comply with UL 514A and NEMA FB 1.

##### 2.6.2 Nonmetallic Ducts

###### 2.6.2.1 Concrete Encased Ducts

UL 651 Schedule 40 or NEMA TC 6 Type EB.

###### 2.6.2.2 Direct Burial

UL 651 Schedule 80, or NEMA TC 6 Type DB.

### 2.6.3 Conduit Sealing Compound

Compounds for sealing ducts and conduit shall have a putty-like consistency workable with the hands at temperatures as low as 2 degrees C (35 degrees F), shall neither slump at a temperature of 150 degrees C (300 degrees F), nor harden materially when exposed to the air. Compounds shall adhere to clean surfaces of fiber or plastic ducts; metallic conduits or conduit coatings; concrete, masonry, or lead; any cable sheaths, jackets, covers, or insulation materials; and the common metals. Compounds shall form a seal without dissolving, noticeably changing characteristics, or removing any of the ingredients. Compounds shall have no injurious effect upon the hands of workmen or upon materials.

## 2.7 TRANSFORMERS, SUBSTATIONS, AND SWITCHGEAR

Transformers, substations, and switchgear shall be of the outdoor type having the ratings and arrangements indicated. Medium-voltage ratings of cable terminations shall be 15 kV between phases for 133 percent insulation level.

### 2.7.1 Pad-Mounted Transformers

Pad-mounted transformers shall comply with ANSI C57.12.26 and shall be of the loop feed type. Pad-mounted transformer stations shall be assembled and coordinated by one manufacturer and each transformer station shall be shipped as a complete unit so that field installation requirements are limited to mounting each unit on a concrete pad and connecting it to primary and secondary lines. Stainless steel pins and hinges shall be provided. Barriers shall be provided between high- and low-voltage compartments. High-voltage compartment doors shall be interlocked with low-voltage compartment doors to prevent access to any high-voltage section unless its associated low-voltage section door has first been opened. Compartments shall be sized to meet the specific dimensional requirements of ANSI C57.12.26. Pentahead locking bolts shall be provided with provisions for a padlock.

#### 2.7.1.1 High-Voltage Compartments

The high-voltage compartment shall be dead-front construction. Primary switching and protective devices shall include loadbreak switching, drawout, dry-well-mounted, current-limiting fuses, medium-voltage separable loadbreak connectors, universal bushing wells and inserts or integral one piece bushings and surge arresters. Fuses shall comply with the requirements of paragraph METERING AND PROTECTIVE DEVICES. The switch shall be mounted inside transformer tank with switch operating handle located in high-voltage compartment and equipped with metal loop for hook stick operation. Fuses shall be interlocked with switches so that fuses can be removed only when the associated switch is in the "OPEN" position. Adjacent to medium-voltage cable connections, a nameplate or equivalent stencilled inscription shall be provided inscribed "DO NOT OPEN CABLE CONNECTORS UNLESS SWITCH IS OPEN." Surge arresters shall be fully insulated and configured to terminate on the same bushing as the primary cable by means of a loadbreak, feed-through bushing insert.

#### 2.7.1.2 Transformer Tank Sections

Transformers shall comply with IEEE C57.12.00, ANSI C57.12.21, and ANSI C57.12.26 and shall be of the mineral oil-insulated type. Transformers shall be suitable for outdoor use and shall have 2 separate windings per phase. Standard NEMA primary taps shall be provided. Where primary taps are not specified, 4, 2-1/2 percent rated kVA high-voltage taps shall be provided 2 above and 2 below rated, primary voltage. Operating handles for primary tap changers for de-energized operation shall be located within high-voltage compartments, externally to transformer tanks. Adjacent to the tap changer operating handle, a nameplate or equivalent stenciled inscription shall be provided and inscribed "DO NOT OPERATE UNDER LOAD." Transformer ratings at 60 Hz shall be as shown on the drawings.

#### 2.7.1.3 Low-Voltage Cable Compartments

Neutrals shall be provided with fully-insulated bushings. Clamp type cable terminations, suitable for copper conductors entering from below, shall be provided as necessary.

#### 2.7.1.4 Accessories

High-voltage warning signs shall be permanently attached to each side of transformer stations. Voltage warning signs shall comply with IEEE C2. Copper-faced steel or stainless steel ground connection pads shall be provided in both the high- and low-voltage compartments. Dial-type thermometer, liquid-level gauge, and drain valve with built-in sampling device shall be provided for each transformer station. Insulated-bushing-type parking stands shall be provided adjacent to each separable load-break elbow to provide for cable isolation during sectionalizing operations.

### 2.8 METERING AND PROTECTIVE DEVICES

#### 2.8.1 Circuit Breakers, Low-Voltage

##### 2.8.1.1 Low-Voltage Power Circuit Breakers

###### a. Construction

Low-voltage power circuit breakers shall conform to IEEE C37.13, ANSI C37.16, and NEMA SG 3 and shall be three-pole, single-throw, stored energy, electrically operated, with drawout mounting. Solid-state trip elements which require no external power connections shall be provided. Circuit breakers shall have an open/close contact indicator, primary disconnect devices, and a mechanical interlock to prevent making or breaking contact of primary disconnections when the circuit breaker is closed. Control voltage shall be 24. The circuit breaker enclosure shall be suitable for its intended location.

###### b. Ratings

Voltage ratings shall be not less than the applicable circuit voltage. Circuit breakers shall be rated for 100 percent continuous duty and shall have trip current ratings and frame sizes as shown. Nominal voltage ratings, maximum continuous-current ratings, and maximum short-circuit interrupting ratings shall be in accordance with ANSI C37.16. Tripping features shall be as follows:

1. Long-time current pick-up, adjustable from 50 percent to 100 percent of sensor current rating.
2. Adjustable long-time delay.
3. Short-time current pick-up, adjustable from 1.5 to 9 times long-time current setting.
4. Adjustable short-time delay.
6. Instantaneous current pick-up, adjustable from 1.5 to 9 times long-time current setting.
7. Ground-fault pick-up, adjustable from 20 percent to 60 percent of sensor rating, but in no case greater than 1200 amperes. Sensing of ground-fault current at the main bonding jumper or ground strap shall not be permitted.
8. Adjustable ground-fault delay.
10. Overload, short-circuit and ground-fault trip indicators shall be provided.

#### 2.8.1.2 Molded-Case Circuit Breakers

NEMA AB 1 and UL 489.

#### 2.8.2 Fuses, Medium-Voltage, Including Current-Limiting

##### 2.8.2.1 Construction

Units shall be suitable for outdoor use. Fuses shall have integral blown-fuse indicators. All ratings shall be clearly visible.

##### 2.8.2.2 Ratings

Current-limiting power fuses shall have ratings in accordance with ANSI C37.46.

##### 2.8.2.3 E-Rated, Current-Limiting Power Fuses

E-rated, current-limiting, power fuses shall conform to ANSI C37.46.

##### 2.8.2.4 C-Rated, Current-Limiting Power Fuses

C-rated, current-limiting power fuses shall open in 1000 seconds at currents between 170 and 240 percent of the C rating.

#### 2.8.3 Fuses, Low-Voltage, Current-Limiting

##### 2.8.3.1 General

Low-voltage fuses shall conform to NEMA FU 1. Time delay and nontime delay options shall be as specified. Equipment provided under this contract shall be provided with a complete set of properly rated fuses when the equipment

manufacturer utilizes fuses in the manufacture of the equipment, or if current-limiting fuses are required to be installed to limit the ampere-interrupting capacity of circuit breakers or equipment to less than the maximum available fault current at the location of the equipment to be installed. Fuses shall have a voltage rating of not less than the phase-to-phase circuit voltage, and shall have the time-current characteristics required for effective power system coordination.

#### 2.8.3.2 Cartridge Fuses

Cartridge fuses, current-limiting type, Class RK5 shall have tested interrupting capacity not less than 200,000 amperes. Fuse holders shall be the type that will reject Class H fuses.

- a. Class J fuses shall conform to UL 198C.
- b. Class K fuses shall conform to UL 198D.
- c. Class R fuses shall conform to UL 198E.
- d. Class T fuses shall conform to UL 198H.

#### 2.8.3.3 Transformer Circuit Fuses

Transformer circuit fuses shall be Class RK1 or RK5, current-limiting, time-delay with 200,000 amperes interrupting capacity.

#### 2.8.4 Instrument Transformers

##### 2.8.4.1 General

Instrument transformers shall comply with ANSI C12.11 and IEEE C57.13. Instrument transformers shall be configured for mounting in/on the device to which they are applied. Polarity marks on instrument transformers shall be visually evident and shown on drawings.

##### 2.8.4.2 Current Transformers

Unless otherwise indicated, bar, wound, or window-type transformers are acceptable; and except for window-type units installed over insulated buses, transformers shall have a BIL rating consistent with the rated BIL of the associated switchgear or electric power apparatus bushings, buses or conductors. Current transformers shall have the indicated ratios. The continuous thermal-current rating factor shall not be less 2.0. Other thermal and mechanical ratings of current transformers and their primary leads shall be coordinated with the design of the circuit breaker and shall be not less than the momentary rating of the associated circuit breaker. Circuit protectors shall be provided across secondary leads of the current transformers to prevent the accident open-circuiting of the transformers while energized. Each terminal of each current transformer shall be connected to a short-circuiting terminal block in the circuit interrupting mechanism cabinet, power transformer terminal cabinet, and in the associated instrument and relay cabinets.



#### 2.8.4.3 Current Transformers for Kwh and Demand Metering (Low-Voltage)

Current transformers shall conform to IEEE C57.13. Provide current transformers with a metering accuracy Class of 0.3 through B-0.5, with a minimum RF of 2 at 30 degrees C, with 600-volt insulations, and 10 kV BIL. Provide butyl-molded, window-type current transformers mounted in the current transformer cabinet.

#### 2.8.4.4 Voltage Transformers

Voltage transformers shall have indicated ratios. Units shall have an accuracy class rating of 0.3. Voltage transformers shall be of the drawout type having current-limiting fuses in both primary and secondary circuits. Mechanical interlocks shall prevent removal of fuses, unless the associated voltage transformer is in a drawout position. Voltage transformer compartments shall have hinged doors.

#### 2.8.5 Watthour Meters

Watthour meters shall comply with ANSI C12.1 and ANSI C12.10, except that numbered terminal wiring sequence and case size may be the manufacturer's standard. Watthour meters shall be of the drawout switchboard type having a 30 minute, cumulative form, demand register meeting ANSI C12.4 and provided with not less than 2-1/2 staters. Watthour demand meters shall have factory-installed electronic pulse initiators meeting the requirements of ANSI C12.1. Pulse initiators shall be solid-state devices incorporating light-emitting diodes, phototransistors, and power transistors, except that mercury-wetted output contacts are acceptable. Initiators shall be totally contained within watthour demand meter enclosures. They shall be capable of operating at speeds up to 500 pulses per minute with no false pulses, and they shall be factory calibrated with no field adjustments being required. Initiators shall be calibrated for a pulse rate output of 1 pulse per 1/4 disc revolution of the associated meter and shall be compatible with the indicated equipment. Meters shall be in accordance with the user's requirements.

#### 2.9 SURGE ARRESTERS

Surge arresters shall comply with NEMA LA 1, IEEE C62.1, IEEE C62.2, and IEEE C62.11 and shall be provided where indicated. Arresters shall be distribution class, rated as shown. Arresters for use at elevations in excess of 1.8 km above mean sea level shall be specifically rated for that purpose. Arresters shall be equipped with mounting brackets suitable for the indicated installations. Arresters shall be of metal-oxide varistor or combination valve-metal-oxide varistor type.

#### 2.10 GROUNDING AND BONDING

##### 2.10.1 Driven Ground Rods

Ground rods shall be copper-clad steel conforming to UL 467 not less than 19 mm in diameter by 3.1 m in length. Sectional type rods may be used.

##### 2.10.2 Grounding Conductors

Grounding conductors shall be bare, except where installed in conduit with associated phase conductors. Insulated conductors shall be of the same

material as phase conductors and green color-coded, except that conductors shall be rated no more than 600 volts. Bare conductors shall be ASTM B 8 soft-drawn unless otherwise indicated. Aluminum is not acceptable.

## 2.11 CONCRETE AND REINFORCEMENT

Concrete work shall have minimum 20 MPa compressive strength and conform to the requirements of Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. Concrete reinforcing shall be as specified in Section 03200 CONCRETE REINFORCEMENT.

## 2.12 PADLOCKS

Padlocks shall conform to ASTM F 883, Type EPC, size 2.

## 2.13 CABLE FIREPROOFING SYSTEMS

Cable fireproofing systems shall be listed in FM P7825 as a fire-protective coating or tape approved for grouped electrical conductors and shall be suitable for application on the type of medium-voltage cables provided. After being fully cured, materials shall be suitable for use where exposed to oil, water, gases, salt water, sewage, and fungus and shall not damage cable jackets or insulation. Asbestos materials are not acceptable.

### 2.13.1 Fireproof Coating

Cable fireproofing coatings shall be compounded of water-based thermoplastic resins, flame-retardant chemicals, and inorganic noncombustible fibers and shall be suitable for the application methods used. Coatings applied on bundled cables shall have a derating factor of less than 5 percent, and a dielectric strength of 95 volts per mil minimum after curing.

### 2.13.2 Fireproofing Tape

Fireproofing tape shall be at least 50 mm wide and shall be a flexible, conformable, polymeric, elastomer tape designed specifically for fireproofing cables.

### 2.13.3 Plastic Tape

Preapplication plastic tape shall be pressure sensitive, 0.254 mm thick, conforming to UL 510.

## 2.14 LIQUID DIELECTRICS

Liquid dielectrics for transformers, capacitors, reclosers, and other liquid-filled electrical equipment shall be non-polychlorinated biphenyl (PCB) mineral-oil or less-flammable liquid as specified. Nonflammable fluids shall not be used. Tetrachloroethylene (perchloroethylene) and 1, 2, 4 trichlorobenzene fluids shall not be used. Liquid dielectrics in retrofitted equipment shall be certified by the manufacturer as having less than 50 parts per million (ppm) PCB content. In lieu of the manufacturer's certification, the Contractor may submit a test sample of the dielectric in accordance with ASTM D 923 and have tests performed per ASTM D 4059 at a testing facility approved by the Contracting Officer. Equipment with test results indicating PCB level exceeding 50 ppm shall be replaced.

## 2.15 FACTORY TESTS

Factory tests shall be performed, as follows, in accordance with the applicable publications and with other requirements of these specifications. The Contracting Officer shall be notified at least 10 days before the equipment is ready for testing. The Contracting Officer reserves the right to witness the tests.

- a. Transformers: Manufacturer's standard tests in accordance with IEEE C57.12.00.
- b. Transformers rated 200 kVA and above: Reduced full-wave, chopped-wave, and full-wave impulse test on each line and neutral terminal, in accordance with IEEE C57.98.
- e. Relaying Current Transformers: Manufacturer's standard tests in accordance with IEEE C57.13.
- f. Instrument Current Transformers: Manufacturer's standard tests in accordance with IEEE C57.13.
- g. Factory Preformed Terminations: Wet withstand voltage tests in accordance with IEEE Std 48 for the next higher BIL level.
- i. Electrical Power Insulators: Manufacturer's standard tests in accordance with ANSI C29.1.

## 2.16 FENCING

Fencing shall conform to the requirements of Section 02831 CHAIN LINK FENCE.

## 3 EXECUTION

### 3.1 GENERAL INSTALLATION REQUIREMENTS

Equipment and devices shall be installed and energized in accordance with the manufacturer's published instructions. Circuits installed aerially shall conform to the requirements of Section 16370 ELECTRICAL DISTRIBUTION SYSTEM, AERIAL. Steel conduits installed underground shall be installed and protected from corrosion in conformance with the requirements of Section 16415 ELECTRICAL WORK, INTERIOR. Except as covered herein, excavation, trenching, and backfilling shall conform to the requirements of Section 02222 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS. Concrete work shall have minimum 20 MPa compressive strength and conform to the requirements of Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE.

#### 3.1.1 Conformance to Codes

The installation shall comply with the requirements and recommendations of NFPA 70 and IEEE C2 as applicable.

#### 3.1.2 Verification of Dimensions

The Contractor shall become familiar with details of the work, shall verify dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

### 3.1.3 Disposal of Liquid Dielectrics

PCB-contaminated dielectrics must be marked as PCB and transported to and incinerated by an approved EPA waste disposal facility. The Contractor shall furnish certification of proper disposal. Contaminated dielectrics shall not be diluted to lower the contamination level.

## 3.2 CABLE AND BUSWAY INSTALLATION

The Contractor shall obtain from the manufacturer an installation manual or set of instructions which addresses such aspects as cable construction, insulation type, cable diameter, bending radius, cable temperature, lubricants, coefficient of friction, conduit cleaning, storage procedures, moisture seals, testing for and purging moisture, etc. The Contractor shall then perform pulling calculations and prepare a pulling plan which shall be submitted along with the manufacturers instructions in accordance with SUBMITTALS.

### 3.2.1 Cable Installation Plan and Procedure

Cable shall be installed strictly in accordance with the cable manufacturer's recommendations. Each circuit shall be identified by means of a fiber, laminated plastic, or non-ferrous metal tags, or approved equal, in each manhole, handhole, junction box, and each terminal. Each tag shall contain the following information; cable type, conductor size, circuit number, circuit voltage, cable destination and phase identification.

#### 3.2.1.1 Cable Inspection

The cable reel shall be inspected for correct storage positions, signs of physical damage, and broken end seals. If end seal is broken, moisture shall be removed from cable in accordance with the cable manufacturer's recommendations.

#### 3.2.1.2 Duct Cleaning

Duct shall be cleaned with an assembly that consists of a flexible mandrel (manufacturers standard product in lengths recommended for the specific size and type of duct) that is 6.4 mm less than inside diameter of duct, 2 wire brushes, and a rag. The cleaning assembly shall be pulled through conduit a minimum of 2 times or until less than a volume of 131 cubic centimeters of debris is expelled from the duct.

#### 3.2.1.3 Duct Lubrication

The cable lubricant shall be compatible with the cable jacket for cable that is being installed. Application of lubricant shall be in accordance with lubricant manufacturer's recommendations.

#### 3.2.1.4 Cable Installation

The Contractor shall provide a cable feeding truck and a cable pulling winch as required. The Contractor shall provide a pulling grip or pulling eye in accordance with cable manufacturer's recommendations. The pulling grip or pulling eye apparatus shall be attached to polypropylene or manilla rope followed by lubricant front end packs and then by power cables. A dynamometer shall be used to monitor pulling tension. Pulling tension shall

not exceed cable manufacturer's recommendations. The Contractor shall not allow cables to cross over while cables are being fed into duct. For cable installation in cold weather, cables shall be kept at 10 degrees temperature for at least 24 hours before installation.

#### 3.2.1.5 Cable Installation Plan

The Contractor shall submit a cable installation plan for all cable pulls in accordance with the detail drawings portion of paragraph SUBMITTALS. Cable installation plan shall include:

- a. Site layout drawing with cable pulls identified in numeric order of expected pulling sequence and direction of cable pull.
- b. List of cable installation equipment.
- c. Lubricant manufacturer's application instructions.
- d. Procedure for resealing cable ends to prevent moisture from entering cable.
- e. Cable pulling tension calculations of all cable pulls.
- f. Cable percentage conduit fill.
- g. Cable sidewall thrust pressure.
- h. Cable minimum bend radius and minimum diameter of pulling wheels used.
- i. Cable jam ratio.
- j. Maximum allowable pulling tension on each different type and size of conductor.
- k. Maximum allowable pulling tension on pulling device.

#### 3.2.2 Duct Line

Cables shall be installed in duct lines where indicated. Cable splices in low-voltage cables shall be made in manholes and handholes only, except as otherwise noted. Cable joints in medium-voltage cables shall be made in manholes or approved pullboxes only. Neutral and grounding conductors shall be installed in the same duct with their associated phase conductors.

#### 3.2.3 Direct-Burial

Cables shall be buried directly in the earth as indicated. Minimum cover from the top of a cable to finished grade shall be 600 mm, but not less than the depth of the frost line.

##### 3.2.3.1 Trenching

Trenches for direct-burial cables shall be excavated to depths required to provide the minimum necessary cable cover. Bottoms of trenches shall be smooth and free of stones and sharp objects. Where bottoms of trenches

comprise materials other than sand, a 75 mm layer of sand shall be laid first and compacted to approximate densities of surrounding firm soil.

#### 3.2.3.2 Cable Burial

Cables shall be unreeled along the sides of or in trenches and carefully placed on sand or earth bottoms. Pulling cables into direct-burial trenches from a fixed reel position will not be permitted, except as required to pull cables through conduits under paving or railroad tracks. Where cables cross, a separation of at least 75 mm shall be provided, unless each cable circuit is protected by a nonmetallic conduit sleeve at the crossing. Where single-conductor cable is installed, all 3 phases and the neutral shall be installed in the same sleeve. Bend radius of any cable shall be not less than 8 times the diameter of the cable. In no case shall cables be left under longitudinal tension. The first 150 mm layer of backfill shall be of sand. Machine compaction shall not be used within 150 mm of the cable.

#### 3.2.3.3 Other Requirements

Where direct-burial cables cross under roads or other paving exceeding 1.5 m in width, such cables shall be installed in concrete-encased ducts. Where direct-burial cables cross under railroad tracks, such cables shall be installed in reinforced concrete-encased ducts. Ducts shall extend at least 300 mm beyond each edge of any paving and at least 1.5 m beyond each side of any railroad tracks. Cables may be pulled into duct from a fixed reel where suitable rollers are provided in the trench. Where direct burial cable transitions to duct-enclosed cable, direct-burial cables shall be centered in duct entrances, and a waterproof nonhardening mastic compound shall be used to facilitate such centering. If paving or railroad tracks are in place where cables are to be installed, coated rigid steel conduits driven under the paving or railroad tracks may be used in lieu of concrete-encased ducts. Damage to conduit coatings shall be prevented by providing ferrous pipe jackets or by predrilling. Where cuts are made in any paving, the paving and subbase shall be restored to their original condition.

#### 3.2.3.4 Medium-Voltage Cable Joints or Low-Voltage Cable Splices

Cable joints or splices in direct-burial cables are not permitted in runs of 305 m or less, nor at intervals of less than 305 m in longer runs, except as required for taps. Locations of cable joints or splices in shorter intervals, where required to avoid obstructions or damage to cables, shall be approved. Cable joints or splices in direct burial installations shall be installed in above-ground junction boxes or in cast metal splice boxes suitable for direct burial use. Cable joints or splices in duct banks shall be made only in manholes, handholes, or pullboxes.

#### 3.2.3.5 Cable Markers

Markers shall be located near the ends of cable runs, at each cable joint or splice, at approximately every 150 m along cable runs, and at changes in direction of cable runs. In addition to markers, a 0.127 mm, brightly colored plastic tape not less than 75 mm (3 inches) in width and suitably inscribed at not more than 3 m (10 feet) on centers, or other approved dig-in warning indication, shall be placed approximately 300 mm below finished grade levels of trenches.

### 3.3 CABLE JOINTS

Medium-voltage cable joints shall be made by qualified cable splicers only. Qualifications of cable splicers shall be submitted in accordance with paragraph SUBMITTALS. Shields shall be applied as required to continue the shielding system through each entire cable joint. Shields may be integrally molded parts of preformed joints. Shields shall be grounded at each joint or in accordance with manufacturer's recommended practice. Cable joints shall provide insulation and jacket equivalent to that of the associated cable. Armored cable joints shall be enclosed in compound-filled, cast-iron or alloy, splice boxes equipped with stuffing boxes and armor clamps of a suitable type and size for the cable being installed.

### 3.4 DUCT LINES

#### 3.4.1 Requirements

Numbers and sizes of ducts shall be as indicated. Duct lines shall be laid with a minimum slope of 100 mm per 30 m. Depending on the contour of the finished grade, the high-point may be at a terminal, a manhole, a handhole, or between manholes or handholes. Short-radius manufactured 90-degree duct bends may be used only for pole or equipment risers, unless specifically indicated as acceptable. The minimum manufactured bend radius shall be 450 mm for ducts of less than 80 mm diameter, and 900 mm for ducts 80 mm or greater in diameter. Otherwise, long sweep bends having a minimum radius of 7.6 m shall be used for a change of direction of more than 5 degrees, either horizontally or vertically. Both curved and straight sections may be used to form long sweep bends, but the maximum curve used shall be 30 degrees and manufactured bends shall be used. Ducts shall be provided with end bells whenever duct lines terminate in manholes or handholes.

#### 3.4.2 Treatment

Ducts shall be kept clean of concrete, dirt, or foreign substances during construction. Field cuts requiring tapers shall be made with proper tools and match factory tapers. A coupling recommended by the duct manufacturer shall be used whenever an existing duct is connected to a duct of different material or shape. Ducts shall be stored to avoid warping and deterioration with ends sufficiently plugged to prevent entry of any water or solid substances. Ducts shall be thoroughly cleaned before being laid. Plastic ducts shall be stored on a flat surface and protected from the direct rays of the sun.

#### 3.4.3 Concrete Encasement

Ducts requiring concrete encasements shall comply with NFPA 70, except that electrical duct bank configurations for ducts 150 mm (6 inches) in diameter shall be determined by calculation and as shown on the drawings. The separation between adjacent electric power and communication ducts shall conform to IEEE C2. Duct line encasements shall be monolithic construction. Where a connection is made to a previously poured encasement, the new encasement shall be well bonded or doweled to the existing encasement. The Contractor shall submit proposed bonding method for approval in accordance with the detail drawing portion of paragraph SUBMITTALS. At any point, except railroad and airfield crossings, tops of concrete encasements shall be not less than the cover requirements listed in NFPA 70. At railroad and airfield crossings, duct lines shall be encased with concrete and reinforced

as indicated to withstand specified surface loadings. Tops of concrete encasements shall be not less than 1.5 m below tops of rails or airfield paving unless otherwise indicated. Where ducts are jacked under existing pavement, rigid steel conduit will be installed because of its strength. To protect the corrosion-resistant conduit coating, predrilling or installing conduit inside a larger iron pipe sleeve (jack-and-sleeve) is required. For crossings of existing railroads and airfield pavements greater than 15 m in length, the predrilling method or the jack-and-sleeve method will be used. Separators or spacing blocks shall be made of steel, concrete, plastic, or a combination of these materials placed not farther apart than 1.2 m on centers. Ducts shall be securely anchored to prevent movement during the placement of concrete and joints shall be staggered at least 150 mm vertically.

#### 3.4.4 Nonencased Direct-Burial

Top of duct lines shall be below the frost line depth, but not less than 600 mm below finished grade and shall be installed with a minimum of 75 mm of earth around each duct, except that between adjacent electric power and communication ducts, 300 mm of earth is required. Bottoms of trenches shall be graded toward manholes or handholes and shall be smooth and free of stones, soft spots, and sharp objects. Where bottoms of trenches comprise materials other than sand, a 75 mm layer of sand shall be laid first and compacted to approximate densities of surrounding firm soil before installing ducts. Joints in adjacent tiers of duct shall be vertically staggered at least 150 mm. The first 150 mm layer of backfill cover shall be sand compacted as previously specified. The rest of the excavation shall be backfilled and compacted in 75 to 150 mm layers. Duct banks may be held in alignment with earth. However, high-tiered banks shall use a wooden frame or equivalent form to hold ducts in alignment prior to backfilling.

#### 3.4.5 Installation of Couplings

Joints in each type of duct shall be made up in accordance with the manufacturer's recommendations for the particular type of duct and coupling selected and as approved.

#### 3.4.6 Duct Line Markers

Duct line markers shall be provided at the ends of long duct line stubouts or for other ducts whose locations are indeterminate because of duct curvature or terminations at completely below-grade structures. In addition to markers, a 0.127 mm brightly colored plastic tape, not less than 75 mm in width and suitably inscribed at not more than 3 m on centers with a continuous metallic backing and a corrosion-resistant 0.0254 mm metallic foil core to permit easy location of the duct line, shall be placed approximately 300 mm below finished grade levels of such lines.

### 3.5 PAD-MOUNTED EQUIPMENT INSTALLATION

Pad-mounted equipment, shall be installed on concrete pads in accordance with the manufacturer's published, standard installation drawings and procedures, except that they shall be modified to meet the requirements of this document. Units shall be installed so that they do not damage equipment or scratch painted or coated surfaces. After installation, surfaces shall be inspected and scratches touched up with a paint or coating provided by the manufacturer especially for this purpose. Three-phase



transformers shall be installed with A-B-C phase sequence. Primary taps shall be set at the nominal voltage setting.

### 3.5.1 Concrete Pads

#### 3.5.1.1 Construction

Concrete pads for pad-mounted electrical equipment may be either pre-fabricated or shall be poured-in-place. Pads shall be constructed as indicated, except that exact pad dimensions and mounting details are equipment specific and are the responsibility of the Contractor. Tops of concrete pads shall be level and shall project 100 mm above finished paving or grade and sloped to drain. Edges of concrete pads shall have 20 mm chamfer. Conduits for primary, secondary, and grounding conductors shall be set in place prior to placement of concrete pads. Where grounding electrode conductors are installed through concrete pads, PVC conduit sleeves shall be installed through the concrete to provide physical protection. To facilitate cable installation and termination, the concrete pad shall be provided with a rectangular hole below the primary and secondary compartments, sized in accordance with the manufacturer's recommended dimensions. Upon completion of equipment installation the rectangular hole shall be filled with masonry grout.

#### 3.5.1.2 Concrete and Reinforcement

Concrete work shall have minimum 20 MPa compressive strength and conform to the requirements of Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. Concrete pad reinforcement shall be in accordance with Section 03200 CONCRETE REINFORCEMENT.

#### 3.5.1.3 Sealing

When the installation is complete, the Contractor shall seal all conduit and other entries into the equipment enclosure with an approved sealing compound. Seals shall be of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, or other foreign matter.

### 3.5.2 Padlocks

Padlocks shall be provided for pad-mounted equipment and for each fence gate. Padlocks shall be keyed as directed by the Contracting Officer.

## 3.6 CONNECTIONS BETWEEN AERIAL AND UNDERGROUND SYSTEMS

Connections between aerial and underground systems shall be made as shown. Underground cables shall be extended up poles in conduit to cable terminations. Conduits shall be secured to the poles by 2-hole galvanized steel pipe straps spaced not more than 3 m apart and with 1 strap not more than 300 mm from any bend or termination. Cable guards shall be secured to poles in accordance with the manufacturer's published procedures. Conduits shall be equipped with bushings to protect cables and minimize water entry. Capnut potheads shall be used to terminate medium-voltage multiple-conductor cable. Cables shall be supported by devices separate from the conduit or guard, near their point of exit from the conduit or guard.

### 3.6.1 Pole Installation

Pole installation shall be in accordance with Section 16370 ELECTRICAL DISTRIBUTION SYSTEM, AERIAL.

### 3.7 CONNECTIONS TO BUILDINGS

Cables shall be extended into the various buildings as indicated, and shall be connected to the first applicable termination point in each building. Interfacing with building interior conduit systems shall be at conduit stubouts terminating 1.5 m outside of a building and 600 mm below finished grade as specified and provided under Section 16415 ELECTRICAL WORK, INTERIOR. After installation of cables, conduits shall be sealed with caulking compound to prevent entrance of moisture or gases into buildings.

### 3.8 GROUNDING

#### 3.8.1 Grounding Electrodes

Grounding electrodes shall be installed as shown on the drawings and as follows:

- a. Driven rod electrodes - Unless otherwise indicated, ground rods shall be driven into the earth until the tops of the rods are approximately 300 mm below finished grade.
- b. Additional electrodes - When the required ground resistance is not met, additional electrodes shall be provided interconnected with grounding conductors to achieve the specified ground resistance. The additional electrodes will be up to three, 3 m rods spaced a minimum of 3 m apart. In high ground resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, the Contracting Officer shall be notified immediately.

#### 3.8.2 Grounding and Bonding Connections

Connections above grade shall be made by the fusion-welding process or with bolted solderless connectors, in compliance with UL 467, and those below grade shall be made by a fusion-welding process. Where grounding conductors are connected to aluminum-composition conductors, specially treated or lined copper-to-aluminum connectors suitable for this purpose shall be used.

#### 3.8.3 Grounding and Bonding Conductors

Grounding and bonding conductors include conductors used to bond transformer enclosures and equipment frames to the grounding electrode system. Grounding and bonding conductors shall be sized as shown, and located to provide maximum physical protection. Bends greater than 45 degrees in ground conductors are not permitted. Routing of ground conductors through concrete shall be avoided. When concrete penetration is necessary, nonmetallic conduit shall be cast flush with the points of concrete entrance and exit so as to provide an opening for the ground conductor, and the opening shall be sealed with a suitable compound after installation.

#### 3.8.4 Surge Arrester Grounding

Surge arresters and neutrals shall be bonded directly to the transformer enclosure and then to the grounding electrode system with a bare copper conductor, sized as shown. Lead lengths shall be kept as short as practicable with no kinks or sharp bends.

#### 3.8.5 Riser Pole Grounding

A single continuous vertical grounding electrode conductor shall be installed on each riser pole and connected directly to the grounding electrodes indicated on the drawings or required by these specifications. All equipment, neutrals, surge arresters, and items required to be grounded shall be connected directly to this vertical conductor. The grounding electrode conductor shall be sized as shown. Grounding electrode conductors shall be stapled to wood poles at intervals not exceeding 600 mm.

### 3.9 FIELD TESTING

#### 3.9.1 General

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer 10 days prior to conducting tests. The Contractor shall furnish all materials, labor, and equipment necessary to conduct field tests. The Contractor shall perform all tests and inspections recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor shall maintain a written record of all tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results. Field test reports shall be signed and dated by the Contractor.

#### 3.9.2 Safety

The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor shall replace any devices or equipment which are damaged due to improper test procedures or handling.

#### 3.9.3 Ground-Resistance Tests

The resistance of each grounding electrode system shall be measured using the fall-of-potential method defined in IEEE Std 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

- a. Single rod electrode - 25 ohms.
- b. Multiple rod electrodes - 25 ohms.

#### 3.9.4 Medium-Voltage Cable Test

After installation and before the operating test or connection to an existing system, the medium-voltage cable system shall be given a high potential test. Direct-current voltage shall be applied on each phase conductor of the system by connecting conductors as one terminal and connecting grounds or metallic shieldings or sheaths of the cable as the other terminal for each test. Prior to making the test, the cables shall be isolated by opening applicable protective devices and disconnecting equipment. The test shall be conducted with all splices, connectors, and terminations in place. The method, voltage, length of time, and other characteristics of the test for initial installation shall be in accordance with NEMA WC 7 or NEMA WC 8 for the particular type of cable installed, except that 28 kV and 35 kV insulation test voltages shall be in accordance with either AEIC CS5 or AEIC CS6 as applicable, and shall not exceed the recommendations of IEEE Std 404 for cable joints and IEEE Std 48 for cable terminations unless the cable and accessory manufacturers indicate higher voltages are acceptable for testing. Should any cable fail due to a weakness of conductor insulation or due to defects or injuries incidental to the installation or because of improper installation of cable, cable joints, terminations, or other connections, the Contractor shall make necessary repairs or replace cables as directed. Repaired or replaced cables shall be retested.

#### 3.9.5 Low-Voltage Cable Test

Low-voltage cable, complete with splices, shall be tested for insulation resistance after the cables are installed, in their final configuration, ready for connection to the equipment, and prior to energization. The test voltage shall be 500 volts dc, applied for one minute between each conductor and ground and between all possible combinations of conductors in the same trench, duct, or cable, with all other conductors in the same trench, duct, or conduit. The minimum value of insulation shall be:

$R \text{ in megohms} = (\text{rated voltage in kV} + 1) \times 304,800 / (\text{length of cable in meters})$

Each cable failing this test shall be repaired or replaced. The repaired cable shall be retested until failures have been eliminated.

#### 3.9.6 Liquid-Filled Transformer Tests

The following field tests shall be performed on all liquid-filled transformers. Pass-fail criteria shall be in accordance with transformer manufacturer's specifications.

- a. Insulation resistance test phase-to-ground.
- b. Turns ratio test.
- c. Correct phase sequence.
- d. Correct operation of tap changer.

### 3.9.7 Circuit Breaker Tests

The following field tests shall be performed on circuit breakers. Pass-fail criteria shall be in accordance with the circuit breaker manufacturer's specifications.

- a. Insulation resistance test phase-to-phase.
- b. Insulation resistance test phase-to-ground.
- c. Closed breaker contact resistance test.
- d. Power factor test.
- e. High-potential test.
- f. Electrical operation of the breaker.

### 3.9.8 Pre-Energization Services

Calibration, testing, adjustment, and placing into service of the installation shall be accomplished by a manufacturer's product field service engineer or independent testing company with a minimum of 2 years of current product experience. The following services shall be performed on the equipment listed below. These services shall be performed subsequent to testing but prior to the initial energization. The equipment shall be inspected to ensure that installation is in compliance with the recommendations of the manufacturer and as shown on the detail drawings. Terminations of conductors at major equipment shall be inspected to ensure the adequacy of connections. Bare and insulated conductors between such terminations shall be inspected to detect possible damage during installation. If factory tests were not performed on completed assemblies, tests shall be performed after the installation of completed assemblies. Components shall be inspected for damage caused during installation or shipment to ensure packaging materials have been removed. Components capable of being both manually and electrically operated shall be operated manually prior to the first electrical operation. Components capable of being calibrated, adjusted, and tested shall be calibrated, adjusted, and tested in accordance with the instructions of the equipment manufacturer. Items for which such services shall be provided, but are not limited to, are the following:

- a. Pad-mounted transformers
- b. Panelboards
- c. Switchboards

### 3.9.9 Operating Tests

After the installation is completed, and at such times as the Contracting Officer may direct, the Contractor shall conduct operating tests for approval. The equipment shall be demonstrated to operate in accordance with the requirements herein. An operating test report shall be submitted in accordance with paragraph SUBMITTALS.

### 3.10 ACCEPTANCE

Final acceptance of the facility will not be given until the Contractor has successfully completed all tests and after all defects in installation, material or operation have been corrected.

## SECTION 16415

## ELECTRICAL WORK, INTERIOR

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1	(1995) Code for Electricity Metering
ANSI C12.4	(1984; R 1996) Mechanical Demand Registers
ANSI C12.10	(1987) Electromechanical Watthour Meters
ANSI C39.1	(1981; R 1992) Requirements for Electrical Analog Indicating Instruments
ANSI C80.5	(1995) Rigid Aluminum Conduit
ANSI C82.4	(1992) Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type)

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 1	(1990) Hard-Drawn Copper Wire
ASTM B 8	(1993) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM D 709	(1992) Laminated Thermosetting Materials

## CODE OF FEDERAL REGULATIONS (CFR)

47 CFR 18	Industrial, Scientific, and Medical Equipment
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## INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C37.20.1	(1993) Metal-Enclosed Low-Voltage Power Circuit-Breaker Switchgear
IEEE C62.41	(1991) Surge Voltages in Low-Voltage AC Power Circuits
IEEE Std 81	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1)

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1991) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA AB 1	(1993) Molded Case Circuit Breakers and Molded Case Switches
NEMA FU 1	(1986) Low Voltage Cartridge Fuses
NEMA ICS 1	(1993) Industrial Control and Systems
NEMA ICS 2	(1993) Industrial Control and Systems Controllers, Contactors, Overload Relays Rated Not More Than 2,000 Volts AC or 750 DC
NEMA ICS 3	(1993) Industrial Control and Systems Factory Built Assemblies
NEMA ICS 6	(1993) Industrial Control and Systems Enclosures
NEMA LE 4	(1987) Recessed Luminaires, Ceiling Compatibility
NEMA MG 1	(1993; Rev 1; Rev 2; Rev 3) Motors and Generators
NEMA MG 10	(1994) Energy Management Guide for Selection and Use of Polyphase Motors
NEMA OS 1	(1989) Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports
NEMA OS 2	(1986; Errata Aug 1986; R 1991) Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports
NEMA PB 1	(1990) Panelboards
NEMA PB 2	(1995) Deadfront Distribution Switchboards
NEMA RN 1	(1989) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA ST 20	(1992) Dry-Type Transformers for General Applications
NEMA TC 2	(1990) Electrical Polyvinyl Chloride (PVC) Tubing (EPT) and Conduit (EPC-40 and EPC-80)
NEMA TC 13	(1993) Electrical Nonmetallic Tubing (ENT)
NEMA WD 1	(1983; R 1989) General Requirements for Wiring Devices



NEMA WD 6 (1988) Wiring Devices - Dimensional Requirements

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (1996) National Electrical Code

NFPA 101 (1997) Safety to Life from Fire in Buildings and Structures

UNDERWRITERS LABORATORIES (UL)

UL-03 (1996; Supple) Electrical Construction Materials Directory

UL 1 (1993; Rev thru Jan 1995) Flexible Metal Conduit

UL 5 (1995) Surface Metal Raceways and Fittings  
UL 6 (1993; Rev Mar 1996) Rigid Metal Conduit

UL 20 (1995; Rev thru Apr 1997) General-Use Snap Switches

UL 44 (1997) Thermoset-Insulated Wires and Cables

UL 50 (1995; Rev Oct 1996) Enclosures for Electrical Equipment

UL 67 (1993; Rev thru Dec 1993) Panelboards

UL 83 (1996) Thermoplastic-Insulated Wires and Cables

UL 98 (1994; R Oct 1995) Enclosed and Dead-Front Switches

UL 198B (1995) Class H Fuses

UL 198C (1986; Rev thru Jun 1993) High-Interrupting-Capacity Fuses, Current-Limiting Types

UL 198D (1995) Class K Fuses

UL 198E (1988; Rev Jul 1988) Class R Fuses

UL 198G (1988; Rev May 1988) Fuses for Supplementary Overcurrent Protection

UL 198H (1988; Rev thru Nov 1993) Class T Fuses

UL 198L (1995; Rev May 1995) D-C Fuses for Industrial Use

UL 360 (1996; Rev Mar 1997) Liquid-Tight Flexible Steel Conduit

UL 467	(1993; Rev thru Aug 1996) Grounding and Bonding Equipment
UL 486A	(1991; Rev Oct 1991) Wire Connectors and Soldering Lugs for Use with Copper Conductors
UL 486C	(1997) Splicing Wire Connectors
UL 486E	(1994; Rev thru Feb 1997) Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors
UL 489	(1996; Rev May 1997) Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
UL 498	(1996) Attachment Plugs and Receptacles
UL 506	(1994; Rev Jul 1994) Specialty Transformers
UL 508	(1993) Industrial Control Equipment
UL 510	(1994) Insulating Tape
UL 512	(1993; R Dec 1995) Fuseholders
UL 514A	(1996) Metallic Outlet Boxes
UL 514B	(1996) Fittings for Conduit and Outlet Boxes
UL 514C	(1996) Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL 542	(1994; Rev May 1997) Lampholders, Starters, and Starter Holders for Fluorescent Lamps
UL 651	(1995; Rev Jan 1997) Schedule 40 and 80 Rigid PVC Conduit
UL 651A	(1995; Rev Sep 1996) Type EB and A Rigid PVC Conduit and HDPE Conduit
UL 674	(1994; Rev thru Feb 1997) Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations
UL 719	(1996) Nonmetallic-Sheathed Cables
UL 797	(1993; Rev thru Mar 1997) Electrical Metallic Tubing
UL 844	(1995; Rev thru Aug 1996) Electric Lighting Fixtures for Use in Hazardous (Classified) Locations
UL 845	(1995; Rev Feb 1996) Motor Control Centers

UL 854	(1996; Rev May 1996) Service-Entrance Cables
UL 869A	(1993; Rev Apr 1994) Reference Standard for Service Equipment
UL 877	(1993; Rev Jul 1995) Circuit Breakers and Circuit-Breaker Enclosures for Use in Hazardous (Classified) Locations
UL 886	(1994; Rev thru Jan 1997) Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations
UL 891	(1994; Rev thru Jan 1995) Dead-Front Switchboards
UL 924	(1995; Rev thru May 95) Emergency Lighting and Power Equipment
UL 935	(1995; Rev thru Apr 1997) Fluorescent-Lamp Ballasts
UL 943	(1993; Rev thru Mar 1997) Ground-Fault Circuit Interrupters
UL 1004	(1994; Rev thru Feb 1997) Electric Motors
UL 1022	(1994) Line Isolation Monitors
UL 1029	(1994; Rev Sep 1995) High-Intensity-Discharge Lamp Ballasts
UL 1047	(1995) Isolated Power Systems Equipment
UL 1236	(1994; Rev thru Apr 1996) Battery Chargers for Charging Engine-Starter Batteries
UL 1242	(1996) Intermediate Metal Conduit
UL 1570	(1995) Fluorescent Lighting Fixtures
UL 1571	(1991; Rev thru Mar 95) Incandescent Lighting Fixtures
UL 1572	(1995; Rev thru Sep 96) High Intensity Discharge Lighting Fixtures
UL 1660	(1994) Liquid-Tight Flexible Nonmetallic Conduit

## 1.2 GENERAL

### 1.2.1 Rules

The installation shall conform to the requirements of NFPA 70 and NFPA 101, unless more stringent requirements are indicated herein or shown.

### 1.2.2 Coordination

The drawings indicate the extent and the general location and arrangement of equipment, conduit, and wiring. The Contractor shall become familiar with all details of the work and verify all dimensions in the field so that the outlets and equipment shall be properly located and readily accessible. Lighting fixtures, outlets, and other equipment and materials shall be located to avoid interference with mechanical or structural features; otherwise, lighting fixtures shall be symmetrically located according to the room arrangement when uniform illumination is required, or asymmetrically located to suit conditions fixed by design and shown. Raceways, junction and outlet boxes, and lighting fixtures shall not be supported from sheet metal roof decks. If any conflicts occur necessitating departures from the drawings, details of and reasons for departures shall be submitted and approved prior to implementing any change. The Contractor shall coordinate electrical work with the HVAC and electrical drawings and specifications and provide power related wiring.

### 1.2.3 Special Environments

#### 1.2.3.1 Weatherproof Locations

Wiring, Fixtures, and equipment in designated locations shall conform to NFPA 70 requirements for installation in damp or wet locations.

#### 1.2.3.2 Ducts, Plenums and Other Air-Handling Spaces

Wiring and equipment in ducts, plenums and other air-handling spaces shall be installed using materials and methods in conformance with NFPA 70 unless more stringent requirements are indicated in this specification or on the contract drawings.

### 1.2.4 Standard Products

Material and equipment shall be a standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

### 1.2.5 NAMEPLATES

#### 1.2.5.1 Identification Nameplates

Major items of electrical equipment and major components shall be permanently marked with an identification name to identify the equipment by type or function and specific unit number as indicated. Designation of motors shall coincide with their designation in the motor control center or panel. Unless otherwise specified, identification nameplates shall be made of laminated plastic in accordance with ASTM D 709 with black outer layers and a white core. Edges shall be chamfered. Plates shall be fastened with black-finished round-head drive screws, except motors, or approved nonadhesive metal fasteners. When the nameplate is to be installed on an irregular-shaped object, the Contractor shall devise an approved support suitable for the application and ensure the proper installation of the supports and nameplates. In all instances, the nameplate shall be installed in a conspicuous location. At the option of the Contractor, the equipment

manufacturer's standard embossed nameplate material with black paint-filled letters may be furnished in lieu of laminated plastic. The front of each panelboard, motor control center, switchgear, and switchboard shall have a nameplate to indicate the phase letter, corresponding color and arrangement of the phase conductors. The following equipment, as a minimum, shall be provided with identification nameplates:

Minimum 6.4 mm High Letters	Minimum 3.2 mm High Letters
Panelboards	Control Power Transformers
Starters	Control Devices
Safety Switches	Instrument Transformers
Motor Control Centers	
Transformers	
Equipment Enclosures	
Switchgear	
Switchboards	
Motors	

Each panel, section, or unit in motor control centers, switchgear or similar assemblies shall be provided with a nameplate in addition to nameplates listed above, which shall be provided for individual compartments in the respective assembly, including nameplates which identify "future," "spare," and "dedicated" or "equipped spaces."

#### 1.2.6 As-Built Drawings

Following the project completion or turnover, within 30 days the Contractor shall furnish two sets of as-built drawings to the Contracting Officer.

#### 1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

##### SD-01 Data

Manufacturer's Catalog; GA.

Data composed of catalog cuts, brochures, circulars, specifications, product data, and printed information in sufficient detail and scope to verify compliance with the requirements of the contract documents.

Material, Equipment, and Fixture Lists; FIO.

A complete itemized listing of equipment and materials proposed for incorporation into the work. Each entry shall include an item number, the quantity of items proposed, and the name of the manufacturer of each item.

Installation Procedures; FIO.

Installation procedures for rotating equipment, transformers, switchgear, battery systems, voltage regulators, and grounding resistors. Procedures

shall include diagrams, instructions, and precautions required to install, adjust, calibrate, and test devices and equipment.

#### SD-04 Drawings

Interior Electrical Equipment; FIO.

Detail drawings consisting of equipment drawings, illustrations, schedules, instructions, diagrams, and other information necessary to define the installation. Detail drawings shall show the rating of items and systems and how the components of an item and system are assembled, function together, and how they will be installed on the project. Data and drawings for component parts of an item or system shall be coordinated and submitted as a unit. Data and drawings shall be coordinated and included in a single submission. Multiple submissions for the same equipment or system are not acceptable except where prior approval has been obtained from the Contracting Officer. In such cases, a list of data to be submitted later shall be included with the first submission. Detail drawings shall show physical arrangement, construction details, connections, finishes, materials used in fabrication, provisions for conduit or busway entrance, access requirements for installation and maintenance, physical size, electrical characteristics, foundation and support details, and equipment weight. Drawings shall be drawn to scale and/or dimensioned. Optional items shall be clearly identified as included or excluded. Detail drawings shall as a minimum include:

- a. Transformers.
- b. Switchgear.
- c. Grounding resistors.
- d. Motors and rotating machinery.
- e. Motor control centers.
- f. Single line electrical diagrams including primary, metering, sensing and relaying, control wiring, and control logic.

Structural drawings showing the structural or physical features of major equipment items, components, assemblies, and structures, including foundations or other types of supports for equipment and conductors. These drawings shall include accurately scaled or dimensioned outline and arrangement or layout drawings to show the physical size of equipment and components and the relative arrangement and physical connection of related components. Weights of equipment, components and assemblies shall be provided when required to verify the adequacy of design and proposed construction of foundations or other types of supports. Dynamic forces shall be stated for switching devices when such forces must be considered in the design of support structures. The appropriate detail drawings shall show the provisions for leveling, anchoring, and connecting all items during installation, and shall include any recommendations made by the manufacturer.

Electrical drawings including single-line and three-line diagrams, and schematics or elementary diagrams of each electrical system; internal wiring and field connection diagrams of each electrical device when published by

the manufacturer; wiring diagrams of cabinets, panels, units, or separate mountings; interconnection diagrams that show the wiring between separate components of assemblies; field connection diagrams that show the termination of wiring routed between separate items of equipment; internal wiring diagrams of equipment showing wiring as actually provided for this project. Field wiring connections shall be clearly identified.

If departures from the contract drawings are deemed necessary by the Contractor, complete details of such departures, including changes in related portions of the project and the reasons why, shall be submitted with the detail drawings. Approved departures shall be made at no additional cost to the Government.

As-Built Drawings; GA.

The as-built drawings shall be a record of the construction as installed. The drawings shall include all the information shown on the contract drawings, deviations, modifications, and changes from the contract drawings, however minor. The as-built drawings shall be kept at the job site and updated daily. The as-built drawings shall be a full-sized set of prints marked to reflect all deviations, changes, and modifications. The as-built drawings shall be complete and show the location, size, dimensions, part identification, and other information. Additional sheets may be added. The as-built drawings shall be jointly inspected for accuracy and completeness by the Contractor's quality control representative and by the Contracting Officer prior to the submission of each monthly pay estimate. Upon completion of the work, the Contractor shall submit three full sized sets of the marked prints to the Contracting Officer for approval. If upon review, the as-built drawings are found to contain errors and/or omissions, they will be returned to the Contractor for correction. The Contractor shall correct and return the as-built drawings to the Contracting Officer for approval within ten calendar days from the time the drawings are returned to the Contractor.

SD-08 Statements

On-Site Test; GA.

A detailed description of the Contractor's proposed procedures for on-site tests.

SD-09 Reports

Factory Test Reports; GA.

Six copies of the information described below in 216 x 280 mm binders having a minimum of 5 rings from which material may readily be removed and replaced, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

- a. A list of equipment used, with calibration certifications.
- b. A copy of measurements taken.
- c. The dates of testing.
- d. The equipment and values to be verified.

- e. The conditions specified for the test.
- f. The test results, signed and dated.
- g. A description of adjustments made.

Field Test Plan; GA.

A detailed description of the Contractor's proposed procedures for on-site test submitted 30 days prior to testing the installed system. No field test will be performed until the test plan is approved. The test plan shall consist of complete field test procedures including tests to be performed, test equipment required, and tolerance limits.

Field Test Reports; GA.

Six copies of the information described below in 216 x 280 mm binders having a minimum of 5 rings from which material may readily be removed and replaced, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

- a. A list of equipment used, with calibration certifications.
- b. A copy of measurements taken.
- c. The dates of testing.
- d. The equipment and values to be verified.
- e. The conditions specified for the test.
- f. The test results, signed and dated.
- g. A description of adjustments made.
- h. Final position of controls and device settings.

SD-13 Certificates

Materials and Equipment; GA.

The label or listing of the Underwriters Laboratories, Inc., will be accepted as evidence that the materials or equipment conform to the applicable standards of that agency. In lieu of this label or listing, a statement from a nationally recognized, adequately equipped testing agency indicating that the items have been tested in accordance with required procedures and that the materials and equipment comply with all contract requirements will be accepted. However, materials and equipment installed in hazardous locations must bear the UL label unless the data submitted from other testing agency is specifically approved in writing by the Contracting Officer. Items which are required to be listed and labeled in accordance with Underwriters Laboratories must be affixed with a UL label that states that it is UL listed. No exceptions or waivers will be granted to this requirement. Materials and equipment will be approved based on the manufacturer's published data.



For other than equipment and materials specified to conform to UL publications, a manufacturer's statement indicating complete compliance with the applicable standard of the American Society for Testing and Materials, National Electrical Manufacturers Association, or other commercial standard, is acceptable.

#### 1.4 WORKMANSHIP

Materials and equipment shall be installed in accordance with NFPA 70, recommendations of the manufacturer, and as shown.

### 2 PRODUCTS

Products shall conform to the respective publications and other requirements specified below. Materials and equipment not listed below shall be as specified elsewhere in this section. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

#### 2.1 CABLES AND WIRES

Conductors No. 8 AWG and larger diameter shall be stranded. Conductors No. 10 AWG and smaller diameter shall be solid, except that conductors for remote control, alarm, and signal circuits, classes 1, 2, and 3, shall be stranded unless specifically indicated otherwise. Conductor sizes and ampacities shown are based on copper, unless indicated otherwise. All conductors shall be copper.

##### 2.1.1 Equipment Manufacturer Requirements

When manufacturer's equipment requires copper conductors at the terminations or requires copper conductors to be provided between components of equipment, provide copper conductors or splices, splice boxes, and other work required to meet manufacturer's requirements.

##### 2.1.2 Insulation

Unless indicated otherwise, or required by NFPA 70, power and lighting wires shall be 600-volt, Type THWN, THHN, or THW conforming to UL 83 or RHW conforming to UL 44, except that grounding wire may be type TW conforming to UL 83; remote-control and signal circuits shall be Type TW, THW or TF, conforming to UL 83. Where lighting fixtures require 90-degree Centigrade (C) conductors, provide only conductors with 90-degree C insulation or better.

##### 2.1.3 Bonding Conductors

ASTM B 1, solid bare copper wire for sizes No. 8 AWG and smaller diameter; ASTM B 8, Class B, stranded bare copper wire for sizes No. 6 AWG and larger diameter.

##### 2.1.4 Non-metallic Sheathed Cable

UL 719, type NM or NMC.

##### 2.1.5 Service Entrance Cables

Service entrance (SE) and underground service entrance (USE) cables, UL 854.

## 2.2 CHARGERS, BATTERY

UL 1236. Battery chargers shall be general purpose, continuous current output, with solid state rectifiers. Means shall be provided to regulate and to adjust the dc output voltage. Chargers shall have continuous current ratings of 10 to 15 percent higher than battery current outputs based upon an 8-hour discharge.

## 2.3 CIRCUIT BREAKERS

### 2.3.1 MOLDED-CASE CIRCUIT BREAKERS

Molded-case circuit breakers shall conform to NEMA AB 1 and UL 489 and UL 877 for circuit breakers and circuit breaker enclosures located in hazardous (classified) locations. Circuit breakers may be installed in panelboards, switchboards, enclosures, motor control centers, or combination motor controllers.

#### 2.3.1.1 Construction

Circuit breakers shall be suitable for mounting and operating in any position. Lug shall be listed for copper conductors only in accordance with UL 486E. Single-pole circuit breakers shall be full module size with not more than one pole per module. Multi-pole circuit breakers shall be of the common-trip type having a single operating handle such that an overload or short circuit on any one pole will result in all poles opening simultaneously. Sizes of 100 amperes or less may consist of single-pole breakers permanently factory assembled into a multi-pole unit having an internal, mechanical, nontamperable common-trip mechanism and external handle ties. All circuit breakers shall have a quick-make, quick-break overcenter toggle-type mechanism, and the handle mechanism shall be trip-free to prevent holding the contacts closed against a short-circuit or sustained overload. All circuit breaker handles shall assume a position between "ON" and "OFF" when tripped automatically. All ratings shall be clearly visible.

#### 2.3.1.2 Ratings

Voltage ratings shall be not less than the applicable circuit voltage. The interrupting rating of the circuit breakers shall be at least equal to the available short-circuit current at the line terminals of the circuit breaker and correspond to the UL listed integrated short-circuit current rating specified for the panelboards and switchboards. Molded-case circuit breakers shall have nominal voltage ratings, maximum continuous-current ratings, and maximum short-circuit interrupting ratings in accordance with NEMA AB 1. Ratings shall be coordinated with system X/R ratio.

#### 2.3.1.3 Cascade System Ratings

Circuit breakers used in series combinations shall be in accordance with UL 489. Equipment, such as switchboards and panelboards, which house series-connected circuit breakers shall be clearly marked accordingly. Series combinations shall be listed in the UL Recognized Component Directory under "Circuit Breakers-Series Connected."

#### 2.3.1.4 Thermal-Magnetic Trip Elements

Thermal magnetic circuit breakers shall be provided as shown. Automatic operation shall be obtained by means of thermal-magnetic tripping devices located in each pole providing inverse time delay and instantaneous circuit protection. The instantaneous magnetic trip shall be adjustable and accessible from the front of all circuit breakers on frame sizes above 150 amperes.

### 2.4 CONDUIT AND TUBING

#### 2.4.1 Electrical, Zinc-Coated Steel Metallic Tubing (EMT)

UL 797

#### 2.4.2 Electrical Nonmetallic Tubing (ENT)

NEMA TC 13.

#### 2.4.3 Electrical Plastic Tubing and Conduit

NEMA TC 2.

#### 2.4.4 Flexible Conduit, Steel and Plastic

General-purpose type, UL 1; liquid tight, UL 360, and UL 1660.

#### 2.4.5 Intermediate Metal Conduit

UL 1242.

#### 2.4.6 PVC Coated Rigid Steel Conduit

NEMA RN 1.

#### 2.4.7 Rigid Aluminum Conduit

ANSI C80.5 and UL 6.

#### 2.4.8 Rigid Metal Conduit

UL 6.

#### 2.4.9 Rigid Plastic

NEMA TC 2, UL 651 and UL 651A.

#### 2.4.10 Surface Metal Electrical Raceways and Fittings

UL 5.

### 2.5 CONDUIT AND DEVICE BOXES AND FITTINGS

#### 2.5.1 Boxes, Metallic Outlet

NEMA OS 1 and UL 514C.

### 2.5.2 Boxes, Nonmetallic, Outlet and Flush-Device Boxes and Covers

NEMA OS 2 and UL 514C.

### 2.5.3 Boxes, Outlet for Use in Hazardous (Classified) Locations

UL 886.

### 2.5.4 Boxes, Switch (Enclosed), Surface-Mounted

UL 98.

### 2.5.5 Fittings for Conduit and Outlet Boxes

UL 514B.

### 2.5.6 Fittings For Use in Hazardous (Classified) Locations

UL 886.

### 2.5.7 Fittings, PVC, for Use with Rigid PVC Conduit and Tubing

UL 514B.

## 2.6 CONDUIT COATINGS PLASTIC RESIN SYSTEM

NEMA RN 1, Type A-40.

## 2.7 CONNECTORS, WIRE PRESSURE

### 2.7.1 For Use With Copper Conductors

UL 486A.

## 2.8 ELECTRICAL GROUNDING AND BONDING EQUIPMENT

UL 467.

### 2.8.1 Ground Rods

Ground rods shall be of copper-clad steel conforming to UL 467 not less than 19.1 mm in diameter by 3.1 meter in length of the sectional type driven full length into the earth.

### 2.8.2 Ground Bus

The ground bus shall be bare conductor or flat copper in one piece, if practicable.

## 2.9 ENCLOSURES

NEMA ICS 6 or NEMA 250 unless otherwise specified.

### 2.9.1 Cabinets and Boxes

Cabinets and boxes with volume greater than 0.0164 cubic meters shall be in accordance with UL 50, hot-dip, zinc-coated, if sheet steel.

### 2.9.2 Circuit Breaker Enclosures

UL 489.

### 2.10 FIXTURES, LIGHTING AND FIXTURE ACCESSORIES/COMPONENTS

Standard Drawing 40-06-04 sheets referenced hereinafter and enclosed as an integral part of these specifications, additional fixtures shown on contract drawings, if any, and UL 844 for fixtures to be installed in hazardous (classified) locations. Fixtures, accessories and components, including ballasts, lampholders, lamps, starters and starter holders, shall conform to industry standards specified below.

#### 2.10.1 Fixture, Auxiliary or Emergency

UL 924.

#### 2.10.2 Incandescent Fixture

NEMA LE 4 for ceiling compatibility of recessed fixtures and UL 1571.

#### 2.10.3 Fluorescent

- a. Fixture: NEMA LE 4 for ceiling compatibility of recessed fixtures and UL 1570. Fixtures shall be plainly marked for proper lamp and ballast type to identify lamp diameter, wattage, color and start type. Marking shall be readily visible to service personnel, but not visible from normal viewing angles.

- b. Ballasts:

(1) Electronic Ballast. Electronic ballasts shall consist of a rectifier, high frequency inverter, and power control and regulation circuitry. The ballasts shall be UL listed, Class P, with a Class A sound rating and shall contain no PCBs. Ballasts shall meet 47 CFR 18 for electromagnetic interference and shall not interfere with the operation of other electrical equipment. Design shall withstand line transients per IEEE C62.41, Category A. Unless otherwise indicated, the minimum number of ballasts shall be used to serve each individual fixture, using one, two, three or four lamp ballasts. A single ballast may be used to serve multiple fixtures if they are continuous mounted, factory manufactured for that installation with an integral wireway, and are identically controlled.

- (a) Light output regulation shall be +/- 10%.
- (b) Voltage input regulation shall be +/- 10%.
- (c) Lamp current crest factor shall be no more than 1.6.
- (d) Ballast factor shall be not less than 85% nor more than 100%, unless otherwise indicated.
- (e) A 60 Hz filter shall be provided. Flicker shall be no more than 10% with any lamp suitable for the ballast.

- (f) Ballast case temperature shall not exceed 25 degree Celsius rise above 40 degree Celsius ambient, when tested in accordance with UL 935.
- (g) Total harmonic distortion shall be in the range of 10-20%.
- (h) Power factor shall not be less than 0.95.
- (i) Ballasts shall operate at a frequency of 20 kHz or more.
- (j) Operating filament voltage shall be 2.5 to 4.5 volts.
- (k) Warranty. Three year full warranty including a \$10 labor allowance.
- (l) Ballast Efficacy Factor (BEF) shall be in accordance with the following table. Ballasts and lamps shall be matching rapid start or instant start as indicated on the following table. If 32W-F32-T8 lamps and ballasts are used, they must be either all rapid start or all instant start.

ELECTRONIC FLUORESCENT BALLAST EFFICACY FACTORS\*

LAMP TYPE	TYPE OF STARTER & LAMP	NOMINAL OPERATIONAL INPUT VOLTAGE	NUMBER OF LAMPS	MIN. BALLAST EFFICACY FACTOR
32W F32 T8	rapid or instant start	120 or 277 V	1	2.4
			2	1.4
			3	1.0
			4	0.8

\*For ballasts not specifically designed for use with dimming controls

The BEF is calculated using the formula:

$BEF = \text{Ballast Factor (in percent)} / \text{Power Input}$

Where Power Input = Total Wattage of Combined Lamps and Ballasts.

- c. Lampholders, Starters, and Starter Holders: UL 542.

#### 2.10.4 High-Intensity-Discharge

- a. Fixture: NEMA LE 4 for ceiling compatibility of recessed fixtures and UL 1572.
- b. Ballasts: ANSI C82.4 for multiple supply types and UL 1029.

#### 2.11 LOW-VOLTAGE FUSES AND FUSEHOLDERS

##### 2.11.1 Fuses, Low Voltage Cartridge Type

NEMA FU 1.

#### 2.11.2 Fuses, High-Interrupting-Capacity, Current-Limiting Type

Fuses, Class G, J, L and CC shall be in accordance with UL 198C.

#### 2.11.3 Fuses, Class K, High-Interrupting-Capacity Type

UL 198D.

#### 2.11.4 Fuses, Class H

UL 198B.

#### 2.11.5 Fuses, Class R

UL 198E.

#### 2.11.6 Fuses, Class T

UL 198H.

#### 2.11.7 Fuses for Supplementary Overcurrent Protection

UL 198G.

#### 2.11.8 Fuses, D-C for Industrial Use

UL 198L.

#### 2.11.9 Fuseholders

UL 512.

#### 2.12 INSTRUMENTS, ELECTRICAL INDICATING

ANSI C39.1.

#### 2.13 MOTORS, AC, FRACTIONAL AND INTEGRAL

Motors, ac, fractional and integral kilowatt, 373.0 kW and smaller shall conform to NEMA MG 1 and UL 1004 for motors; NEMA MG 10 for energy management selection of polyphase motors; and UL 674 for use of motors in hazardous (classified) locations.

##### 2.13.1 Rating

The kilowatt rating of motors should be limited to no more than 125 percent of the maximum load being served unless a NEMA standard size does not fall within this range. In this case, the next larger NEMA standard motor size should be used.

##### 2.13.2 Motor Efficiencies

All permanently wired polyphase motors of 746 W or more shall meet the minimum full-load efficiencies as indicated in the following table, and as specified in this specification. Motors of 746 W or more with open, drip proof or totally enclosed fan cooled enclosures shall be high efficiency type, unless otherwise indicated. Motors provided as an integral part of

motor driven equipment are excluded from this requirement if a minimum seasonal or overall efficiency requirement is indicated for that equipment by the provisions of another section.

#### Minimum Motor Efficiencies

Efficiency	kW	Std. Efficiency	High
	0.746	77.0	85.5
	1.12	78.5	85.5
	1.49	78.5	85.5
	2.24	78.5	88.5
	3.73	82.5	88.5
	5.60	84.0	90.0
	7.46	85.5	90.0
	11.2	85.5	91.0
	14.9	87.5	92.0
	18.7	88.5	92.0
	22.4	88.5	92.0
	29.8	88.5	92.0
	37.3	89.0	92.5
	44.8	89.0	92.5
	56.9	89.0	95.5
	74.6	90.0	93.5
	93.3	91.0	94.5
	112	91.0	94.5
	149	91.0	94.5
	187	91.0	94.5
	224	91.0	94.5
	261	91.0	94.5
	298	91.0	94.5
	373	91.0	94.5

## 2.14 MOTOR CONTROLS AND MOTOR CONTROL CENTERS

### 2.14.1 General

NEMA ICS 1, NEMA ICS 2, NEMA ICS 3 and NEMA ICS 6, and UL 508 and UL 845. Panelboards supplying non-linear loads shall have neutrals sized for 200 percent of rated current.

### 2.14.2 Motor Starters

Combination starters shall be provided with circuit breakers, and fusible switches.

### 2.14.3 Thermal-Overload Protection

Each motor of 93 W (1/8 hp) or larger shall be provided with thermal-overload protection. Polyphase motors shall have overload protection in each ungrounded conductor. The overload-protection device shall be provided either integral with the motor or controller, or shall be mounted in a separate enclosure. Unless otherwise specified, the protective device shall be of the manually reset type. Single or double pole tumbler switches specifically designed for alternating-current operation only may be used as



manual controllers for single-phase motors having a current rating not in excess of 80 percent of the switch rating.

## 2.15 PANELBOARDS

Dead-front construction, NEMA PB 1 and UL 67.

## 2.16 RECEPTACLES

### 2.16.1 Standard Grade

UL 498.

### 2.16.2 Ground Fault Interrupters

UL 943, Class A or B.

### 2.16.3 NEMA Standard Receptacle Configurations

NEMA WD 6.

a. Single and Duplex, 15-Ampere and 20-Ampere, 125 Volt  
15-ampere, non-locking: NEMA type 5-15R, locking: NEMA type L5-15R, 20-ampere, non-locking: NEMA type 5-20R, locking: NEMA type L5-20R.

b. 15-Ampere, 250 Volt

Two-pole, 3-wire grounding, non-locking: NEMA type 6-15R, locking: NEMA type L6-15R. Three-pole, 4-wire grounding, non-locking: NEMA type 15-15R, locking: NEMA type L15-15R.

## 2.17 SERVICE ENTRANCE EQUIPMENT

UL 869A.

## 2.18 SPLICE, CONDUCTOR

UL 486C.

## 2.19 POWER-SWITCHGEAR ASSEMBLIES INCLUDING SWITCHBOARDS

Assemblies shall be metal-enclosed, freestanding general-purpose type in accordance with NEMA PB 2, UL 891, and IEEE C37.20.1 and shall be installed to provide front and rear access. Assembly shall be approximately 2.3 meters high; arrangement of circuit breakers and other items specified shall be as indicated. The withstand rating and interrupting capacity of the switchboards and circuit breakers shall be based on the maximum fault current available.

### 2.19.1 Circuit Breakers

Circuit breakers shall be molded-case circuit breakers

#### 2.19.1.1 Control Switch

A control switch with indicating lights shall be provided for each electrically operated breaker.

## 2.20 SNAP SWITCHES

UL 20.

## 2.21 TAPES

### 2.21.1 Plastic Tape

UL 510.

### 2.21.2 Rubber Tape

UL 510.

## 2.22 TRANSFORMERS

Single- and three-phase transformers shall have two windings per phase. Full-capacity standard NEMA taps shall be provided in the primary windings of transformers unless otherwise indicated. Three-phase transformers shall be configured with delta-wye windings, except as indicated. "T" connections may be used for transformers rated 15 kVA or below.

### 2.22.1 Transformers, Dry-Type

Transformers shall have 220 degrees C insulation system for transformers 15 kVA and greater, and shall have 180 degrees C insulation system for transformers rated 10 kVA and less, with temperature rise not exceeding 150 degrees C under full-rated load in maximum ambient temperature of 40 degrees C. Transformer of 150 degrees C temperature rise shall be capable of carrying continuously 100 percent of nameplate kVA without exceeding insulation rating.

#### a. 600 Volt or Less Primary:

NEMA ST 20, UL 506, general purpose, dry-type, self-cooled, ventilated. Provide transformers in NEMA 1 enclosure.

### 2.22.2 Average Sound Level

The average sound level in decibels (dB) of transformers shall not exceed the following dB level at 300 mm for the applicable kVA rating range listed unless otherwise indicated:

kVA Range	dB Sound Level
1-50	50
51-150	55
151-300	58
301-500	60
501-700	62
701-1000	64
1001-1500	65
1501 & above	70

## 2.23 ISOLATED POWER SYSTEM EQUIPMENT

UL 1047, with monitor UL 1022.

## 2.24 WATTHOUR METERS, UTILITY REVENUE

Watthour meters shall conform to ANSI C12.1 and ANSI C12.10, except numbered terminal wiring sequence and case size may be the manufacturer's standard. Watthour meters shall be of the drawout switchboard type having a 15-minute, cumulative form, demand register meeting ANSI C12.4 and provided with not less than two and one-half staters. Watthour demand meters shall have factory-installed electronic pulse initiators meeting the requirements of ANSI C12.1. Pulse initiators shall be solid-state devices incorporating light-emitting diodes, phototransistors, and power transistors, except that mercury-wetted output contacts are acceptable. Initiators shall be totally contained within watthour demand meter enclosures, shall be capable of operating up to speeds of 500 pulses per minute with no false pulses, and shall require no field adjustments. Initiators shall be calibrated for a pulse rate output of one pulse per 1/4 disc revolution of the associated meter and shall be compatible with the indicated equipment.

## 2.25 WIRING DEVICES

NEMA WD 1 for wiring devices, and NEMA WD 6 for dimensional requirements of wiring devices.

## 3 EXECUTION

### 3.1 GROUNDING

Grounding shall be in conformance with NFPA 70, the contract drawings, and the following specifications.

#### 3.1.1 Ground Rods

The resistance to ground shall be measured using the fall-of-potential method described in IEEE Std 81. The maximum resistance of a driven ground shall not exceed 25 ohms under normally dry conditions. If this resistance cannot be obtained with a single rod, 3 additional rods not less than 1.8 meters on centers. In high-ground-resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, the Contracting Officer shall be notified immediately. Connections below grade shall be fusion welded. Connections above grade shall be fusion welded or shall use UL 467 approved connectors.

#### 3.1.2 Grounding Conductors

All equipment grounding conductors, including metallic raceway systems used as such, shall be bonded or joined together in each wiring box or equipment enclosure. Metallic raceways and grounding conductors shall be checked to assure that they are wired or bonded into a common junction. Metallic boxes and enclosures, if used, shall also be bonded to these grounding conductors by an approved means per NFPA 70. When boxes for receptacles, switches, or other utilization devices are installed, any designated grounding terminal on these devices shall also be bonded to the equipment grounding conductor junction with a short jumper.

### 3.2 WIRING METHODS

Wiring shall conform to NFPA 70, the contract drawings, and the following specifications. Unless otherwise indicated, wiring shall consist of insulated conductors installed in rigid aluminum conduit, rigid zinc-coated steel conduit, or electrical metallic tubing. In the barracks buildings nonmetallic-sheathed cable is allowed for branch circuits only and shall conform to NFPA 70. Where cables and wires are installed in cable trays, they shall be of the type permitted by NFPA 70 for use in such applications. Wire fill in conduits shall be based on NFPA 70 for the type of conduit and wire insulations specified. Wire fill in conduits located in Class I or II hazardous areas shall be limited to 25 percent of the cross sectional area of the conduit.

#### 3.2.1 Conduit and Tubing Systems

Conduit and tubing systems shall be installed as indicated. Conduit sizes shown are based on use of copper conductors with insulation types as described in paragraph WIRING METHODS. Minimum size of raceways shall be 15 mm. Only metal conduits will be permitted when conduits are required for shielding or other special purposes indicated, or when required by conformance to NFPA 70. Nonmetallic conduit and tubing may be used in damp, wet or corrosive locations when permitted by NFPA 70 and the conduit or tubing system is provided with appropriate boxes, covers, clamps, screws or other appropriate type of fittings. Electrical metallic tubing (EMT) may be installed only within buildings. EMT may be installed in concrete and grout in dry locations. EMT installed in concrete or grout shall be provided with concrete tight fittings. EMT shall not be installed in damp or wet locations, or the air space of exterior masonry cavity walls. Bushings, manufactured fittings or boxes providing equivalent means of protection shall be installed on the ends of all conduits and shall be of the insulating type, where required by NFPA 70. Only UL listed adapters shall be used to connect EMT to rigid metal conduit, cast boxes, and conduit bodies. Aluminum conduit may be used only where installed exposed in dry locations. Nonaluminum sleeves shall be used where aluminum conduit passes through concrete floors and firewalls. Penetrations of above grade floor slabs, time-rated partitions and fire walls shall be firestopped in accordance with Section 07270 FIRESTOPPING. Except as otherwise specified, IMC may be used as an option for rigid steel conduit in areas as permitted by NFPA 70. Raceways shall not be installed under the firepits of boilers and furnaces and shall be kept 150 mm away from parallel runs of flues, steam pipes and hot-water pipes. Raceways shall be concealed within finished walls, ceilings, and floors unless otherwise shown. Raceways crossing structural expansion joints or seismic joints shall be provided with suitable expansion fittings or other suitable means to compensate for the building expansion and contraction and to provide for continuity of grounding. Wiring installed in underfloor raceway system shall be suitable for installation in wet locations.

##### 3.2.1.1 Pull Wires

A pull wire shall be inserted in each empty raceway in which wiring is to be installed if the raceway is more than 15 meters in length and contains more than the equivalent of two 90-degree bends, or where the raceway is more than 45 meters in length. The pull wire shall be of No. 14 AWG zinc-coated

steel, or of plastic having not less than 1.4 MPa tensile strength. Not less than 254 mm of slack shall be left at each end of the pull wire.

#### 3.2.1.2 Conduit Stub-Ups

Where conduits are to be stubbed up through concrete floors, a short elbow shall be installed below grade to transition from the horizontal run of conduit to a vertical run. A conduit coupling fitting, threaded on the inside shall be installed, to allow terminating the conduit flush with the finished floor. Wiring shall be extended in rigid threaded conduit to equipment, except that where required, flexible conduit may be used 150 mm above the floor. Empty or spare conduit stub-ups shall be plugged flush with the finished floor with a threaded, recessed plug.

#### 3.2.1.3 Below Slab-on-Grade or in the Ground

Electrical wiring below slab-on-grade shall be protected by a conduit system. Conduit passing vertically through slabs-on-grade shall be rigid steel or IMC. Rigid steel or IMC conduits installed below slab-on-grade or in the earth shall be field wrapped with 0.254 mm thick pipe-wrapping plastic tape applied with a 50 percent overlay, or shall have a factory-applied polyvinyl chloride, plastic resin, or epoxy coating system.

#### 3.2.1.4 Installing in Slabs Including Slabs on Grade

Conduit installed in slabs-on-grade shall be rigid steel or IMC. Conduits shall be installed as close to the middle of concrete slabs as practicable without disturbing the reinforcement. Outside diameter shall not exceed 1/3 of the slab thickness and conduits shall be spaced not closer than 3 diameters on centers except at cabinet locations where the slab thickness shall be increased as approved by the Contracting Officer. Where conduit is run parallel to reinforcing steel, the conduit shall be spaced a minimum of one conduit diameter away but not less than 25.4 mm from the reinforcing steel.

#### 3.2.1.5 Changes in Direction of Runs

Changes in direction of runs shall be made with symmetrical bends or cast-metal fittings. Field-made bends and offsets shall be made with an approved hickey or conduit-bending machine. Crushed or deformed raceways shall not be installed. Trapped raceways in damp and wet locations shall be avoided where possible. Care shall be taken to prevent the lodgment of plaster, dirt, or trash in raceways, boxes, fittings and equipment during the course of construction. Clogged raceways shall be cleared of obstructions or shall be replaced.

#### 3.2.1.6 Supports

Except where otherwise permitted by NFPA 70, conduits and tubing shall be securely and rigidly fastened in place at intervals of not more than 3 meters and within 900 mm of boxes, cabinets, and fittings, with approved pipe straps, wall brackets, conduit clamps, conduit hangers, threaded C-clamps, beam clamps, or ceiling trapeze. Loads and supports shall be coordinated with supporting structure to prevent damage or deformation to the structure. Loads shall not be applied to joist bridging. Attachment shall be by wood screws or screw-type nails to wood; by toggle bolts on hollow masonry units; by expansion bolts on concrete or brick; by machine

screws, welded threaded studs, heat-treated or spring-steel-tension clamps on steel work. Nail-type nylon anchors or threaded studs driven in by a powder charge and provided with lock washers and nuts may be used in lieu of expansion bolts or machine screws. Raceways or pipe straps shall not be welded to steel structures. Cutting the main reinforcing bars in reinforced concrete beams or joists shall be avoided when drilling holes for support anchors. Holes drilled for support anchors, but not used, shall be filled. In partitions of light steel construction, sheet-metal screws may be used. Raceways shall not be supported using wire or nylon ties. Raceways shall be independently supported from the structure. Upper raceways shall not be used as a means of support for lower raceways. Supporting means will not be shared between electrical raceways and mechanical piping or ducts. Cables and raceways shall not be supported by ceiling grids. Except where permitted by NFPA 70, wiring shall not be supported by ceiling support systems. Conduits shall be fastened to sheet-metal boxes and cabinets with two locknuts where required by NFPA 70, where insulating bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, a single locknut and bushing may be used. Threadless fittings for electrical metallic tubing shall be of a type approved for the conditions encountered. Additional support for horizontal runs is not required when EMT rests on steel stud cutouts.

#### 3.2.1.7 Exposed Raceways

Exposed raceways shall be installed parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceilings. Raceways under raised floors and above accessible ceilings shall be considered as exposed installations in accordance with NFPA 70 definitions.

#### 3.2.1.8 Exposed Risers

Exposed risers in wire shafts of multistory buildings shall be supported by U-clamp hangers at each floor level, and at intervals not to exceed 3 meters.

#### 3.2.1.9 Communications Raceways

Communications raceways indicated shall be installed in accordance with the previous requirements for conduit and tubing and with the additional requirements that no length of run shall exceed 15 meters for 15 mm and 20 mm sizes, and 30 meters for 25 mm or larger sizes, and shall not contain more than two 90-degrees bends or the equivalent. Additional pull or junction boxes shall be installed to comply with these limitations whether or not indicated. Inside radii of bends in conduits of 25 mm (1 inch) size or larger shall not be less than ten times the nominal diameter.

#### 3.2.2 Cables and Conductors

Installation shall conform to the requirements of NFPA 70. Covered, bare or insulated conductors of circuits rated over 600 volts shall not occupy the same equipment wiring enclosure, cable, or raceway with conductors of circuits rated 600 volts or less.

##### 3.2.2.1 Sizing

Unless otherwise noted, all sizes are based on copper conductors and the insulation types indicated. Sizes shall be not less than indicated.

Branch-circuit conductors shall be not smaller than No. 12 AWG. Conductors for branch circuits of 120 volts more than 30 meters long and of 277 volts more than 70 meters long, from panel to load center, shall be no smaller than No. 10 AWG. Class 1 remote control and signal circuit conductors shall be not less than No. 14 AWG. Class 2 remote control and signal circuit conductors shall be not less than No. 16 AWG. Class 3 low-energy, remote-control and signal circuits shall be not less than No. 22 AWG.

#### 3.2.2.2 Cable Systems

Cable systems shall be installed where indicated. Cables shall be installed concealed behind ceiling or wall finish where practicable. Cables shall be threaded through holes bored on the approximate centerline of wood members; notching of surfaces will not be permitted. Sleeves shall be provided through bond beams of masonry-block walls for threading cables through hollow spaces. Exposed cables shall be installed parallel or at right angles to walls or structural members. In rooms or areas not provided with ceiling or wall finish, cables and outlets shall be installed so that a room finish may be applied in the future without disturbing the cables or resetting the boxes. Exposed nonmetallic-sheathed cables less than 1.2 meters above floors shall be protected from mechanical injury by installation in conduit or tubing.

#### 3.2.2.3 Cable Splicing

Splices shall be made in an accessible location. Crimping tools and dies shall be approved by the connector manufacturer for use with the type of connector and conductor.

- a. Copper Conductors, 600 Volt and Under: Splices in conductors No. 10 AWG and smaller diameter shall be made with an insulated, pressure-type connector. Splices in conductors No. 8 AWG and larger diameter shall be made with a solderless connector and insulated with tape or heat-shrink type insulating material equivalent to the conductor insulation.
- b. Greater Than 600 Volt: Cable splices shall be made in accordance with the cable manufacturer's recommendations and Section 16375 ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND.

#### 3.2.2.4 Conductor Identification and Tagging

Power, control, and signal circuit conductor identification shall be provided within each enclosure where a tap, splice, or termination is made. Where several feeders pass through a common pull box, the feeders shall be tagged to indicate clearly the electrical characteristics, circuit number, and panel designation. Phase conductors of low voltage power circuits shall be identified by color coding. Phase identification by a particular color shall be maintained continuously for the length of a circuit, including junctions.

- a. Color coding shall be provided for service, feeder, branch, and ground conductors. Color shall be green for grounding conductors and white for neutrals; except where neutrals of more than one system are installed in the same raceway or box, other neutral shall be white with colored (not green) stripe. The color coding for three-phase and single-phase low voltage systems shall be as follows:

120/208-volt, 3-phase: Black(A), red(B), and blue(C).  
277/480-volt, 3-phase: Brown(A), orange(B), and yellow(C).  
120/240-volt, 1-phase: Black and red.

- b. Conductor phase and voltage identification shall be made by color-coded insulation for all conductors smaller than No. 6 AWG. For conductors No. 6 AWG and larger, identification shall be made by color-coded insulation, or conductors with black insulation may be furnished and identified by the use of half-lapped bands of colored electrical tape wrapped around the insulation for a minimum of 75 mm of length near the end, or other method as submitted by the Contractor and approved by the Contracting Officer.
- c. Control and signal circuit conductor identification shall be made by color-coded insulated conductors, plastic-coated self-sticking printed markers, permanently attached stamped metal foil markers, or equivalent means as approved. Control circuit terminals of equipment shall be properly identified. Terminal and conductor identification shall match that shown on approved detail drawings. Hand lettering or marking is not acceptable.

### 3.3 BOXES AND SUPPORTS

Boxes shall be provided in the wiring or raceway systems where required by NFPA 70 for pulling of wires, making connections, and mounting of devices or fixtures. Pull boxes shall be furnished with screw-fastened covers. Indicated elevations are approximate, except where minimum mounting heights for hazardous areas are required by NFPA 70. Unless otherwise indicated, boxes for wall switches shall be mounted 1.2 meters above finished floors. Switch and outlet boxes located on opposite sides of fire rated walls shall be separated by a minimum horizontal distance of 600 mm. The total combined area of all box openings in fire rated walls shall not exceed 0.0645 square meters per 9.3 square meters. Maximum box areas for individual boxes in fire rated walls vary with the manufacturer and must not exceed the maximum specified for that box in UL-03. Only boxes listed in UL-03 shall be used in fire rated walls.

#### 3.3.1 Box Applications

Each box shall have not less than the volume required by NFPA 70 for number of conductors enclosed in box. Boxes for metallic raceways, 102 by 102 mm nominal size and smaller, shall be of the cast-metal hub type when located in normally wet locations, when flush and surface mounted on outside of exterior surfaces, or when located in hazardous areas. Cast-metal boxes installed in wet locations and boxes installed flush with the outside of exterior surfaces shall be gasketed. Boxes for mounting lighting fixtures shall be not less than 102 mm square, or octagonal, except smaller boxes may be installed as required by fixture configuration, as approved. Cast-metal boxes with 2.4 mm wall thickness are acceptable. Large size boxes shall be



NEMA 1 or as shown. Boxes in other locations shall be sheet steel except that aluminum boxes may be used with aluminum conduit, and nonmetallic boxes may be used with nonmetallic conduit and tubing or nonmetallic sheathed cable system, when permitted by NFPA 70. Boxes for use in masonry-block or tile walls shall be square-cornered, tile-type, or standard boxes having square-cornered, tile-type covers.

### 3.3.2 Brackets and Fasteners

Boxes and supports shall be fastened to wood with wood screws or screw-type nails of equal holding strength, with bolts and metal expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screw or welded studs on steel work. Threaded studs driven in by powder charge and provided with lockwashers and nuts, or nail-type nylon anchors may be used in lieu of expansion shields, or machine screws. Penetration of more than 38.1 mm into reinforced-concrete beams or more than 19.1 mm into reinforced-concrete joists shall avoid cutting any main reinforcing steel. The use of brackets which depend on gypsum wallboard or plasterboard for primary support will not be permitted. In partitions of light steel construction, bar hangers with 25 mm long studs, mounted between metal wall studs or metal box mounting brackets shall be used to secure boxes to the building structure. When metal box mounting brackets are used, additional box support shall be provided on the side of the box opposite the brackets. This additional box support shall consist of a minimum 300 mm long section of wall stud, bracketed to the opposite side of the box and secured by two screws through the wallboard on each side of the stud. Metal screws may be used in lieu of the metal box mounting brackets.

### 3.3.3 Mounting in Walls, Ceilings, or Recessed Locations

In walls or ceilings of concrete, tile, or other non-combustible material, boxes shall be installed so that the edge of the box is not recessed more than 6 mm from the finished surface. Boxes mounted in combustible walls or ceiling material shall be mounted flush with the finished surface. The use of gypsum or plasterboard as a means of supporting boxes will not be permitted. Boxes installed for concealed wiring shall be provided with suitable extension rings or plaster covers, as required. The bottom of boxes installed in masonry-block walls for concealed wiring shall be mounted flush with the top of a block to minimize cutting of the blocks, and boxes shall be located horizontally to avoid cutting webs of block. Separate boxes shall be provided for flush or recessed fixtures when required by the fixture terminal operating temperature, and fixtures shall be readily removable for access to the boxes unless ceiling access panels are provided.

### 3.3.4 Installation in Overhead Spaces

In open overhead spaces, cast-metal boxes threaded to raceways need not be separately supported except where used for fixture support; cast-metal boxes having threadless connectors and sheet metal boxes shall be supported directly from the building structure or by bar hangers. Hangers shall not be fastened to or supported from joist bridging. Where bar hangers are used, the bar shall be attached to raceways on opposite sides of the box and the raceway shall be supported with an approved type fastener not more than 600 mm from the box.

### 3.4 DEVICE PLATES

One-piece type device plates shall be provided for all outlets and fittings. Plates on unfinished walls and on fittings shall be of zinc-coated sheet steel, cast-metal, or impact resistant plastic having rounded or beveled edges. Plates on finished walls shall be impact-resistant plastic and shall be the same color as the mounting surface or shall coordinate with the color of the respective mounting surface. Screws shall be of metal with countersunk heads, in a color to match the finish of the plate. Plates shall be installed with all four edges in continuous contact with finished wall surfaces without the use of mats or similar devices. Plaster fillings will not be permitted. Plates shall be installed with an alignment tolerance of 1.6 mm. The use of sectional-type device plates will not be permitted. Plates installed in wet locations shall be gasketed and provided with a hinged, gasketed cover, unless otherwise specified.

### 3.5 RECEPTACLES

#### 3.5.1 Single and Duplex, 15 or 20-ampere, 125 volt

Single and duplex receptacles shall be rated 20 amperes, 125 volts, two-pole, three-wire, grounding type with polarized parallel slots. Body color shall match color of switch handles in the same room or to harmonize with the color of the respective wall, and supported by mounting strap having plaster ears. Contact arrangement shall be such that contact is made on two sides of an inserted blade. Receptacle shall be side- or back-wired with two screws per terminal. The third grounding pole shall be connected to the metal mounting yoke. Switched receptacles shall be the same as other receptacles specified except that the ungrounded pole of each suitable receptacle shall be provided with a separate terminal. Only the top receptacle of a duplex receptacle shall be wired for switching application. Receptacles with ground fault circuit interrupters shall have the current rating as indicated, and shall be UL Class A type unless otherwise shown. Ground fault circuit protection shall be provided as required by NFPA 70 and as indicated on the drawings.

#### 3.5.2 Weatherproof Applications

Weatherproof receptacles shall be suitable for the environment, damp or wet as applicable, and the housings shall be labeled to identify the allowable use. Receptacles shall be marked in accordance with UL 514A for the type of use indicated; "Damp locations", "Wet Locations", "Wet Location Only When Cover Closed". Assemblies shall be installed in accordance with the manufacturer's recommendations.

##### 3.5.2.1 Damp Locations

Receptacles in damp locations shall be mounted in an outlet box with a gasketed, weatherproof, cast-metal cover plate (device plate, box cover) and a gasketed cap (hood, receptacle cover) over each receptacle opening. The cap shall be either a screw-on type permanently attached to the cover plate by a short length of bead chain or shall be a flap type attached to the cover with a spring loaded hinge.

#### 3.5.2.2 Wet Locations

Receptacles in wet locations shall be installed in an assembly rated for such use whether the plug is inserted or withdrawn, unless otherwise indicated. In a duplex installation, the receptacle cover shall be configured to shield the connections whether one or both receptacles are in use.

#### 3.5.3 Special-Purpose or Heavy-Duty Receptacles

Special-purpose or heavy-duty receptacles shall be of the type and of ratings and number of poles indicated or required for the anticipated purpose. Contact surfaces may be either round or rectangular. One appropriate straight or angle-type plug shall be furnished with each receptacle. Locking type receptacles, rated 30 amperes or less, shall be locked by rotating the plug. Locking type receptacles, rated more than 50 amperes, shall utilize a locking ring.

### 3.6 WALL SWITCHES

Wall switches shall be of the totally enclosed tumbler type. The wall switch handle and switch plate color shall coordinate with the color of the respective mounting surface. Wiring terminals shall be of the screw type or of the solderless pressure type having suitable conductor-release arrangement. Not more than two switches shall be installed in a single-gang position. Switches shall be rated 20-ampere 120 or 277-volt for use on alternating current only.

### 3.7 SERVICE EQUIPMENT

Service-disconnecting means shall be of the enclosed molded-case circuit breaker type as indicated with an external handle for manual operation. When service disconnecting means is a part of an assembly, the assembly shall be listed as suitable for service entrance equipment. Enclosures shall be sheet metal with hinged cover for surface mounting unless otherwise indicated.

### 3.8 PANELBOARDS AND LOADCENTERS

Circuit breakers and switches used as a motor disconnecting means shall be capable of being locked in the open position. Door locks shall be keyed alike. Nameplates shall be as approved. Directories shall be typed to indicate loads served by each circuit and mounted in a holder behind a clear protective covering. Busses shall be copper.

#### 3.8.1 Loadcenters

Loadcenters shall be circuit breaker equipped.

#### 3.8.2 Panelboards

Panelboards shall be circuit breaker or fusible switch equipped as indicated on the drawings. Multipole fusible switches shall be of the hinged-door type; single pole fusible switches shall be of the tumbler switch and fuse type. Switches serving as a motor disconnect means shall be of the tumbler switch and fuse type. Switches serving as motor disconnect means shall be horsepower rated in conformance with UL 98.

### 3.9 FUSES

Equipment provided under this contract shall be provided with a complete set of properly rated fuses when the equipment manufacturer utilize fuses in the manufacture of the equipment, or if current-limiting fuses are required to be installed to limit the ampere-interrupting capacity of circuit breakers or equipment to less than the maximum available fault current at the location of the equipment to be installed. Fuses shall have a voltage rating of not less than the phase-to-phase circuit voltage, and shall have the time-current characteristics required for effective power system coordination.

#### 3.9.1 Cartridge Fuses; Noncurrent-Limiting Type

Cartridge fuses of the noncurrent-limiting type shall be Class H, nonrenewable, dual element, time lag type and shall have interrupting capacity of 10,000 amperes. At 500 percent current, cartridge fuses shall not blow in less than 10 seconds.

#### 3.9.2 Cartridge Fuses; Current-Limiting Type

Cartridge fuses, current-limiting type, Class J shall have tested interrupting capacity not less than 100,000 amperes. Fuse holders shall be the type that will reject all Class H fuses.

#### 3.9.3 Motor and Transformer Circuit Fuses

Motor, motor controller, transformer, and inductive circuit fuses shall be Class RK1 or RK5, current-limiting, time-delay with 200,000 amperes interrupting capacity.

### 3.10 UNDERGROUND SERVICE

Unless otherwise indicated, interior conduit systems shall be stubbed out 1.5 m beyond the building wall and 600 mm below finished grade, for interface with the exterior service lateral conduits and exterior communications conduits. Outside conduit ends shall be bushed when used for direct burial service lateral conductors. Outside conduit ends shall be capped or plugged until connected to exterior conduit systems. Underground service lateral conductors will be extended to building service entrance and terminated in accordance with the requirements of Section 16375 ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND and NFPA 70.

### 3.11 MOTORS

Each motor shall conform to the kW and voltage ratings indicated, and shall have a service factor and other characteristics that are essential to the proper application and performance of the motors under conditions shown or specified. Three-phase motors for use on 3-phase 208-volt systems shall have a nameplate rating of 200 volts. Unless otherwise specified, all motors shall have open frames, and continuous-duty classification based on a 40 degree C ambient temperature reference. Polyphase motors shall be squirrel-cage type, having normal-starting-torque and low-starting-current characteristics, unless other characteristics are specified in other sections of these specifications or shown on contract drawings. The Contractor shall be responsible for selecting the actual kilowatt

(horsepower) ratings and other motor requirements necessary for the applications indicated. When electrically driven equipment furnished under other sections of these specifications materially differs from the design, the Contractor shall make the necessary adjustments to the wiring, disconnect devices and branch-circuit protection to accommodate the equipment actually installed.

### 3.12 MOTOR CONTROL

Each motor or group of motors requiring a single control shall be provided under other sections of these specifications with a suitable controller and devices that will perform the functions as specified for the respective motors. Each motor of 93 W (1/8 hp) or larger shall be provided with thermal-overload protection. Polyphase motors shall have overload protection in each ungrounded conductor. The overload-protection device shall be provided either integral with the motor or controller, or shall be mounted in a separate enclosure. Unless otherwise specified, the protective device shall be of the manually reset type. Single or double pole tumbler switches specifically designed for alternating-current operation only may be used as manual controllers for single-phase motors having a current rating not in excess of 80 percent of the switch rating. Automatic control devices such as thermostats, float or pressure switches may control the starting and stopping of motors directly, provided the devices used are designed for that purpose and have an adequate kilowatt rating. When the automatic-control device does not have such a rating, a magnetic starter shall be used, with the automatic-control device actuating the pilot-control circuit. When combination manual and automatic control is specified and the automatic-control device operates the motor directly, a double-throw, three-position tumbler or rotary switch shall be provided for the manual control; when the automatic-control device actuates the pilot control circuit of a magnetic starter, the latter shall be provided with a three-position selector switch marked MANUAL-OFF-AUTOMATIC. Connections to the selector switch shall be such that only the normal automatic regulatory control devices will be bypassed when the switch is in the Manual position; all safety control devices, such as low- or high-pressure cutouts, high-temperature cutouts, and motor-overload protective devices, shall be connected in the motor-control circuit in both the Manual and the Automatic positions of the selector switch. Control circuit connections to any MANUAL-OFF-AUTOMATIC switch or to more than one automatic regulatory control device shall be made in accordance with wiring diagram approved by the Contracting Officer unless such diagram is included on the drawings. All controls shall be 120 volts or less unless otherwise indicated.

#### 3.12.1 Reduced-Voltage Controllers

Reduced-voltage controllers shall be provided for polyphase motors 18.65 kW (25 hp) or larger. Reduced-voltage starters shall be of the single-step autotransformer, reactor, or resistor type having an adjustable time interval between application of reduced and full voltages to the motors. Wye-delta reduced voltage starters or part winding increment starters having an adjustable time delay between application of voltage to first and second winding of motor may be used in lieu of the reduced voltage starters specified above for starting of motor-generator sets, centrifugally operated equipment or reciprocating compressors provided with automatic unloaders.

### 3.12.2 Contacts

Unless otherwise indicated, contacts in miscellaneous control devices such as float switches, pressure switches, and auxiliary relays shall have current and voltage ratings in accordance with NEMA ICS 2 for rating designation B300.

### 3.12.3 Safety Controls

Safety controls for boilers shall be connected to a 2-wire, 120 volt grounded circuit supplied from the associated boiler-equipment circuit. Where the boiler circuit is more than 120 volts to ground, safety controls shall be energized through a two-winding transformer having its 120 volt secondary winding grounded. Overcurrent protection shall be provided in the ungrounded secondary conductor and shall be sized for the load encountered.

### 3.13 MOTOR-DISCONNECT MEANS

Each motor shall be provided with a disconnecting means when required by NFPA 70 even though not indicated. For single-phase motors, a single or double pole toggle switch, rated only for alternating current, will be acceptable for capacities less than 30 amperes, provided the ampere rating of the switch is at least 125 percent of the motor rating. Switches shall disconnect all ungrounded conductors.

### 3.14 TRANSFORMER INSTALLATION

Three-phase transformers shall be connected only in a delta-wye or wye-delta configuration as. "T" connections may be used for transformers rated at 15 kVA or below. Dry-type transformers shown located within 1.5 meters of the exterior wall shall be provided in a weatherproof enclosure. Transformers to be located within the building may be provided in the manufacturer's standard, ventilated indoor enclosure designed for use in 40 degrees C ambient temperature, unless otherwise indicated.

### 3.15 LAMPS AND LIGHTING FIXTURES

Ballasted fixtures shall have ballasts which are compatible with the specific type and rating of lamps indicated and shall comply with the applicable provisions of the publications referenced.

#### 3.15.1 Lamps

Lamps of the type, wattage, and voltage rating indicated shall be delivered to the project in the original cartons and installed in the fixtures just prior to the completion of the project.

##### 3.15.1.1 Incandescent

Incandescent lamps shall be for 125-volt operation unless otherwise indicated.

##### 3.15.1.2 Fluorescent

Fluorescent lamps for magnetic ballasts shall be as indicated and shall be of a type that will not require starter switches. Lamps shall be of the

rapid-start type unless otherwise shown or approved. Fluorescent lamps for electronic ballasts shall be as indicated.

#### 3.15.1.3 High-Intensity-Discharge

High-intensity-discharge lamps shall be the high-pressure sodium type unless otherwise indicated, shown, or approved.

#### 3.15.2 Fixtures

Fixtures shall be as shown and shall conform to the following specifications and shall be as detailed on Standard [Drawing No. 40-06-04](#), Sheet Nos. 9, 20, 31, 32, 36, 39, 40, 51, 56, 65, 66, which accompany and form a part of this specification for the types indicated. Illustrations shown on these sheets are indicative of the general type desired and are not intended to restrict selection to fixtures of any particular manufacturer. Fixtures of similar designs and equivalent energy efficiency, light distribution and brightness characteristics, and of equal finish and quality will be acceptable if approved. In suspended acoustical ceilings with fluorescent fixtures, the fluorescent emergency light fixtures shall be furnished with self-contained battery packs.

##### 3.15.2.1 Accessories

Accessories such as straps, mounting plates, nipples, or brackets shall be provided for proper installation. Open type fluorescent fixtures with exposed lamps shall have a wire-basket type guard.

##### 3.15.2.2 Suspended Fixtures

Suspended fixtures shall be provided with swivel hangers in order to ensure a plumb installation. Pendants, rods, or chains 1.2 meters or longer excluding fixture, shall be braced to limit swinging. Bracing shall be 3 directional, 120 degrees apart. Single unit suspended fluorescent fixtures shall have twin-stem hangers. Multiple unit or continuous-row fluorescent units shall have a tubing or stem for wiring at one point, and a tubing or rod suspension provided for each length of chassis including one at each end. Maximum distance between adjacent tubing or stems shall be 3.1 meters. Rods shall be of not less than 4.8 mm diameter. Flexible raceway shall be installed to each fixture from an overhead junction box. Fixture to fixture wiring installation is allowed only when fixtures are installed end to end in a continuous run.

##### 3.15.2.3 Ceiling Fixtures

Ceiling fixtures shall be coordinated with and suitable for installation in, on, or from the suspended ceiling provided under other sections of these specifications. Installation and support of fixtures shall be in accordance with the NFPA 70 and manufacturer's recommendations. Recessed fixtures shall have adjustable fittings to permit alignment with ceiling panels. Recessed fixtures installed in fire-resistive type of suspended ceiling construction shall have the same fire rating as the ceiling or shall be provided with fireproofing boxes having materials of the same fire rating as the ceiling panels, in conformance with UL-03. Surface-mounted fixtures shall be suitable for fastening to the structural support for ceiling panels.

#### 3.15.2.4 Sockets

Sockets of industrial, strip, and other open type fluorescent fixtures shall be of the type requiring a forced movement along the longitudinal axis of the lamp for insertion and removal of the lamp.

#### 3.15.3 Emergency Light Sets

Emergency light sets shall conform to UL 924 with the number of heads as indicated. Sets shall be permanently connected to the wiring system by conductors installed in short lengths of flexible conduit.

#### 3.16 BATTERY CHARGERS

Battery chargers shall be installed in conformance with NFPA 70.

#### 3.17 EQUIPMENT CONNECTIONS

All wiring not furnished and installed under other sections of the specifications for the connection of electrical equipment as indicated on the drawings shall be furnished and installed under this section of the specifications. Connections shall comply with the applicable requirements of paragraph WIRING METHODS. Flexible conduits 2 m or less in length shall be provided to all electrical equipment subject to periodic removal, vibration, or movement and for all motors. All motors shall be provided with separate grounding conductors. Liquid-tight conduits shall be used in damp or wet locations.

##### 3.17.1 Motors and Motor Control

Motors, motor controls, and motor control centers shall be installed in accordance with NFPA 70, the manufacturer's recommendations, and as indicated. Wiring shall be extended to motors, motor controls, and motor control centers and terminated.

#### 3.18 CIRCUIT PROTECTIVE DEVICES

The Contractor shall calibrate, adjust, set and test each new adjustable circuit protective device to ensure that they will function properly prior to the initial energization of the new power system under actual operating conditions.

#### 3.19 PAINTING AND FINISHING

Field-applied paint on exposed surfaces shall be provided under Section 09900 PAINTING, GENERAL.

#### 3.20 REPAIR OF EXISTING WORK

The work shall be carefully laid out in advance, and where cutting, channeling, chasing, or drilling of floors, walls, partitions, ceiling, or other surfaces is necessary for the proper installation, support, or anchorage of the conduit, raceways, or other electrical work, this work shall be carefully done, and any damage to building, piping, or equipment shall be repaired by skilled mechanics of the trades involved at no additional cost to the Government.



### 3.21 FIELD TESTING

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer 20 days prior to conducting tests. The Contractor shall furnish all materials, labor, and equipment necessary to conduct field tests. The Contractor shall perform all tests and inspection recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor shall maintain a written record of all tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results. All field test reports will be signed and dated by the Contractor.

#### 3.21.1 Safety

The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor shall replace any devices or equipment which are damaged due to improper test procedures or handling.

#### 3.21.2 Ground-Resistance Tests

The resistance of each grounding electrode system shall be measured using the fall-of-potential method defined in IEEE Std 81. Soil resistivity in the area of the grid shall be measured concurrently with the grid measurements. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

- a. Single rod electrode - 25 ohms.

##### 3.21.2.1 Low Voltage Cable Tests

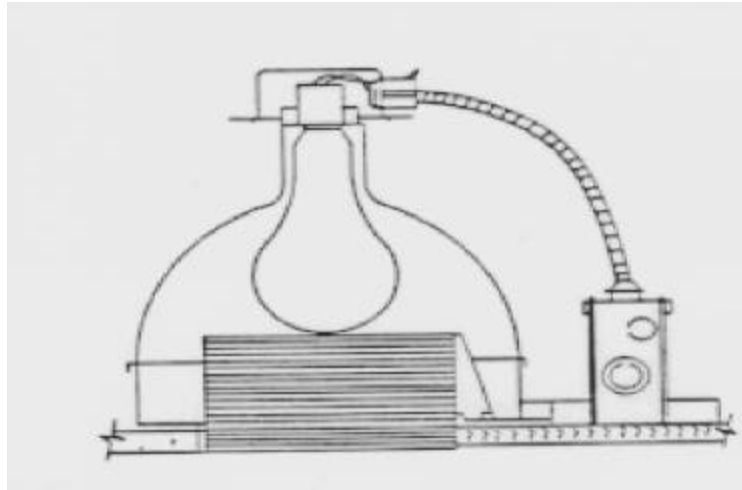
- a. Continuity test.
- b. Insulation resistance test.

### 3.22 OPERATING TESTS

After the installation is completed, and at such time as the Contracting Officer may direct, the Contractor shall conduct operating tests for approval. The equipment shall be demonstrated to operate in accordance with the specified requirements. An operating test report shall be submitted in accordance with paragraph FIELD TEST REPORTS.

### 3.23 ACCEPTANCE

Final acceptance of the facility will not be given until the Contractor has successfully completed all tests and after all defects in installation, material or operation have been corrected.

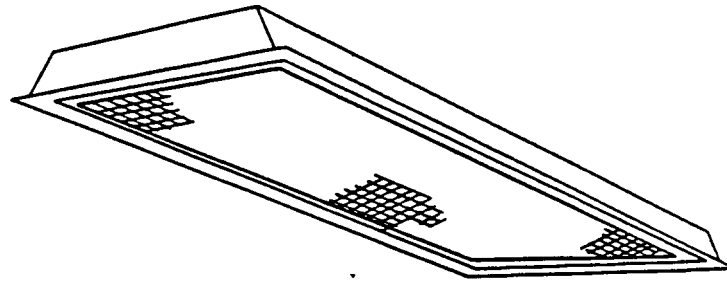


## TYPE 116

## Recessed Round Incandescent Downlight

Fixture shall conform to UL 1571. Fixture shall have thermal protection or shall be UL listed as suitable for use in direct contact with insulation. Fixture shall be rated for a 200 watt lamp. The mounting plate shall be steel. The reflector shall be highly polished aluminum. The shield shall be black, constructed of aluminum, and multigrooved for low brightness. The shield shall be securely attached to the fixture housing and shall be easily removed without the use of tools. Fixture shall be provided with a through wiring junction box and shall be prewired.

Fixture type indicated on this sheet shall also conform to requirements specified and indicated in the contract documents.



TYPE 206  
Static Troffer

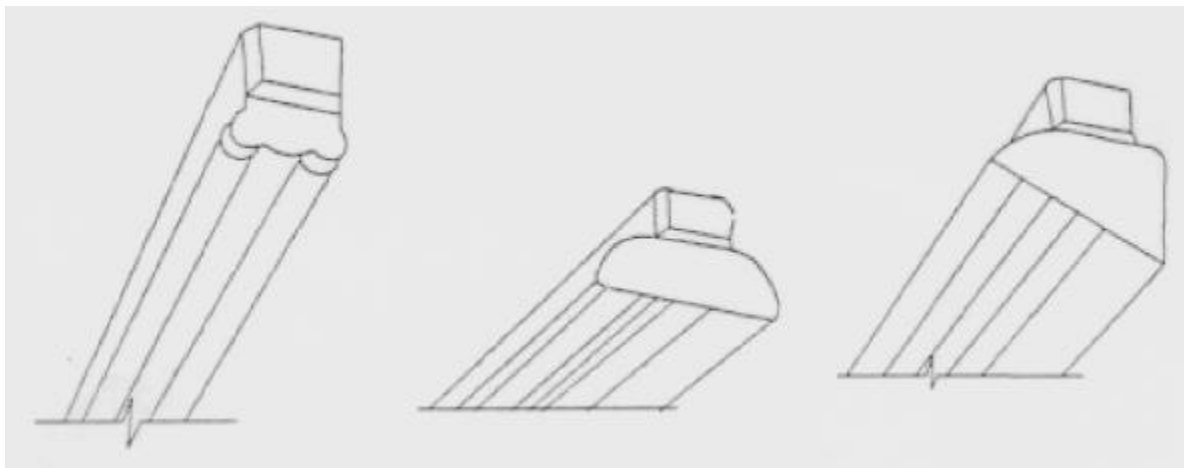
TYPE 207  
Air Handling Troffer

Recessed Fluorescent Fixture, 2-foot by 4-foot

First Suffix	Second Suffix	Third Suffix	Description
A			Prismatic acrylic lens
B			1/2- by 1/2- by 1/2-inch cube louver
C			1/2- by 1/2- by 1/2-inch polystyrene cube louver
	1		Two lamps
	2		Three lamps
	3		Four lamps
		A	Type 200 emergency unit

Fixture shall conform to UL 1570. Housing shall be complete with integral side trim flanges and shall be suitable for mounting in continuous rows. Housing and trim flanges shall be cold-rolled steel. The lens or louver shall be installed in a manner that will prevent it from coming loose due to vibration. The ballasts and wiring shall be enclosed in a wireway that is continuous throughout the length of the fixture and which forms a wireway for circuits through the fixture. All metal parts shall receive a rust inhibitive coating before application of the finish coat. The finish coat shall be baked enamel. Lenses and acrylic cube louvers shall be 100 percent virgin acrylic plastic. The lens or louver shall be four feet in length. Acrylic lens shall be flat, 0.125 inch nominal thickness, low brightness, with smooth top surface and a lower surface having a regular array of prismatic elements. Two-lamp ballasts shall be used for individually mounted two-lamp fixtures and where two-lamp fixtures occur at the ends of continuous rows. Two-lamp ballasts shall be used for tandem mounted fixtures. Standard ballast(s) shall be the Class P, high power factor type which has been approved for the application by the Certified Ballast Manufacturers. Fixture shall be prewired.

Fixture types indicated on this sheet shall also conform to requirements specified and indicated in the contract documents.



TYPE 220  
Without  
Reflector

TYPE 221  
With Symmetric  
Reflector

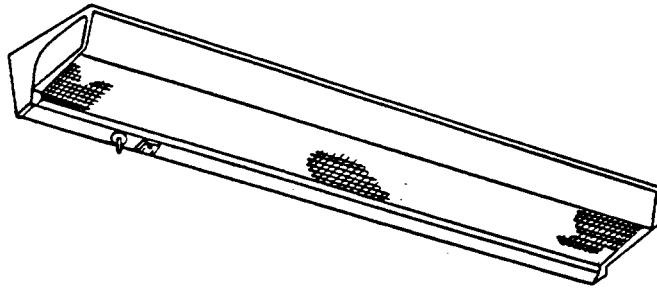
TYPE 222  
With Asymmetric  
Reflector

#### Single- and Two-Lamp Fluorescent Strip Fixture

Suffix	Description
A	One lamp
B	Two lamps

Fixture shall be constructed of cold-rolled steel and shall conform to UL 1570. The fixture shall have a die-formed steel channel, suitable mounting holes, and 1/2-inch knockouts in back. Channel and end fittings shall have a baked white enamel finish. The channel and end fittings shall be removed to permit the installation of a continuous row of fixtures, the closure of fixtures at the ends of continuous rows, and the closure of the ends of individually mounted fixtures with no light leakage. Channel covers shall have threaded fittings for reflector mounting, shall be constructed of die-formed steel, and shall be finished with baked white enamel. All ferrous metal parts shall receive a rust inhibitive coating before application of finish coat. Reflectors shall be designed for direct attachment to the channel cover with suitable threaded fittings. Reflectors shall be manufacturer's standard commercial product and shall be constructed of die-formed aluminum with highly polished finish, or steel with white porcelain enamel finish, or steel with baked white enamel finish. Fixture shall be suitable for pendant and surface mounting. Standard ballast(s) shall be the Class P, high power factor type which has been approved for the application by the Certified Ballast Manufacturers. Fixture shall be prewired. Sockets shall be of the type requiring a forced movement along the longitudinal axis of the lamp for insertion and removal of the lamp. Fluorescent tubes shall be protected by a virgin acrylic protective sleeve and clear plastic vented end caps.

Fixture types indicated on this sheet shall also conform to requirements specified and indicated in the contract documents.



TYPE 223  
Two Lamps

Enclosed, Wall Mounted, Direct And/Or Indirect  
Fluorescent Fixture

Fixture shall be constructed of cold-rolled steel and shall conform to UL 1570. Ferrous metal surfaces shall be treated with 5-stage coating of zinc phosphate and finished in baked white enamel. Seams shall be sealed or gasketed to prevent light leakage. The lens shall be 0.125 inch nominal thickness (minimum 0.115 inch) of 100 percent virgin clear acrylic plastic, with a regular array of prismatic elements on one surface and smooth on the other. Receptacle shall be 2-pole, 3-wire, rated at 15 amperes and 125 volts, and shall be of the grounding type. On/off pull chain switch shall be provided for downlight. Upward light shall be controlled from a wall switch. Fixture shall have knockouts in the back for wiring through an outlet box and a grounding terminal. Standard ballast shall be the Class P, high power factor type which has been approved for the application by the Certified Ballast Manufacturers. Fixture shall be prewired.

Fixture type indicated on this sheet shall also conform to requirements specified and indicated in the contract documents.

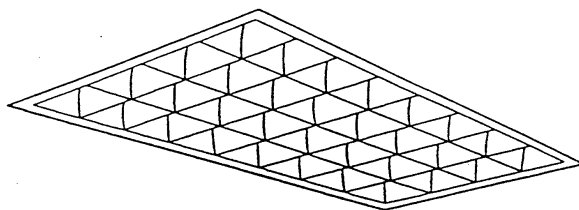


TYPE 230  
Suspension Mounted, Industrial,  
Open Type Fluorescent Fixture, 4-foot

First-Suffix	Second-Suffix	Description
A		Two lamps
B		Three lamps
	1	8 to 15 percent uplight
	2	18 to 25 percent uplight

Fixture shall conform to UL 1570. Standard ballast(s) shall be the Class P, high power factor type approved for the application by the Certified Ballast Manufacturers. Channel housing, end fittings, and reflector shall be porcelain enamel, baked white enamel or aluminum oxide. Sockets shall be of the type requiring a forced movement along the longitudinal axis of the lamp for insertion and removal of the lamp. Fixture shall be prewired. Fluorescent tubes shall be protected by a virgin acrylic protective sleeve and clear plastic vented end caps.

Fixture type indicated on this sheet shall also conform to requirements specified and indicated in the contract documents.



TYPE 234  
Static Troffer

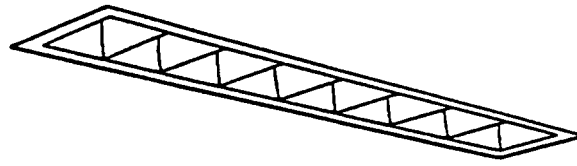
Recessed Fluorescent Fixture, 2-foot by 4-foot, With Parabolic Louver

Description

Three-lamp, 18-cell louver

Fixture shall conform to UL 1570. Housing, trim flanges if any, shall be die-formed, cold-rolled steel embossed if necessary to ensure structural rigidity. Metal parts to be painted shall receive one or more rust inhibitive coatings before application of the finish coat. Reflective surfaces shall be finished to provide an initial and minimum reflectance of not less than 85 percent. The louver shall be the anodized or semi-specular finished aluminum type consisting of inter-connected cellular baffles not less than three nor more than four inches in depth. The louver shall be hinged on either longitudinal side using die-formed steel hinges, and shall be held securely in place by the hinges and spring-steel latches that are inconspicuous or concealed from view when louver is in place and latches are closed. Securing the louver in place shall prevent light leakage and movement of the louver when subjected to normal vibrations. The ballast(s) and fixture wiring shall be concealed by a snap-in type of metal cover which can be removed and replaced without the use of tools. Standard ballast(s) shall be of the Class P, high power factor type that has been approved by the Certified Ballast Manufacturers for the application. Ballast(s), lampholders, louver and the wireway cover shall be removable and replaceable without removal of the fixture from the ceiling. Fixture shall be prewired.

Fixture type indicated on this sheet shall also conform to requirements specified and indicated in the contract documents.



TYPE 237  
Static Troffer

TYPE 238  
Air Handling

TYPE 239  
Heat Removal/  
Transfer Troffer

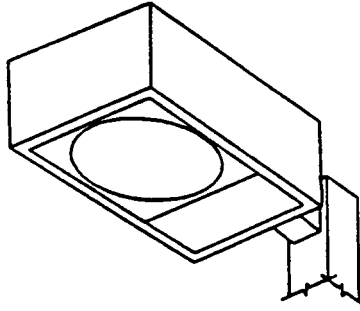
Recessed Fluorescent Fixture, 1-foot by 4-foot, with parabolic louver

First Suffix	Second Suffix	Description
A		Single lamp, 8-cell louver
B		Two-lamp, 8-cell louver
C		Two-lamp, 16-cell louver
	1	Type 100 emergency unit

Fixture shall conform to UL 1570. Housing, trim flanges if any, and end fittings shall be die-formed, cold-rolled steel embossed if necessary to ensure structural rigidity. End fittings shall be removable if required to permit end-to-end mounting of fixtures in a continuous row. Metal parts to be painted shall receive one or more rust inhibitive coatings before the application of the finish coat. Reflective surfaces shall be finished to provide an initial and minimum reflectance of not less than 85 percent. The louver shall be the anodized or semi-specular finished aluminum type consisting of interconnected cellular baffles not less than three nor more than four inches in depth. The louver shall be hinged on both longitudinal sides using die-formed steel hinges, and shall be held securely in place by the hinges and spring-steel latches that are inconspicuous or concealed from view when louver is in place and latches are closed. Securing of the louver in place shall prevent light leakage and movement of the louver when subjected to normal vibrations. The ballast(s) and fixture wiring shall be concealed by a snap-in type of metal cover which can be removed and replaced without the use of tools. Standard ballast(s) shall be of the Class P, high power factor type that has been approved by the Certified Ballast Manufacturers for the application. Ballast(s), lampholders, louver and the wireway cover shall be removable and replaceable without removal of the fixture from the ceiling. Fixture shall be prewired.

Fixture types indicated on this sheet shall also conform to requirements specified and indicated in the contract documents.





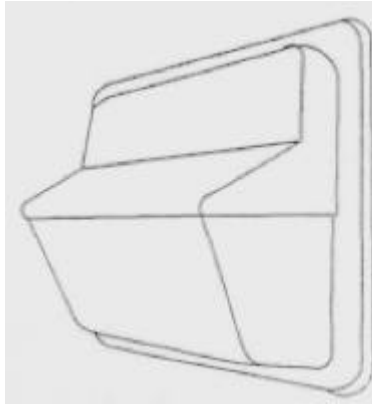
TYPE 401

Enclosed, Integrally Ballasted, Rectangular Shaped,  
Side Mounted, High Intensity Discharge Lighting Fixture

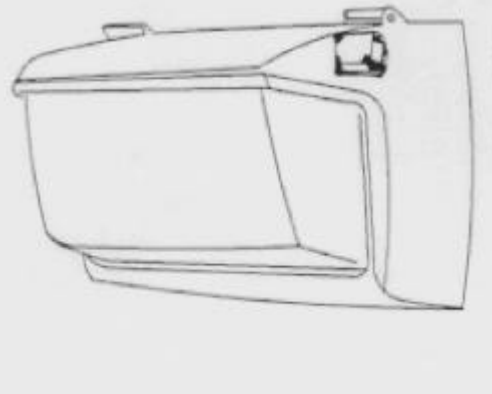
First Suffix	Second Suffix	Description
A		Rated for mercury vapor lamp
B		Rated for metal halide lamp
C		Rated for high pressure sodium lamp
	1	IES type II medium light distribution
	2	IES type III medium light distribution
	3	IES type V medium light distribution

Fixture shall conform to UL 1572. Fixture housing shall have sides and doorframe of one-piece extruded aluminum with welded joints and top of crowned sheet aluminum. The top shall be spot welded and sealed watertight. The housing shall be rigidly attached to a square shaped mounting arm of extruded aluminum. The fixture door shall have a flat heat and impact resistant lens of 3/16 inch nominal, tempered glass, and shall be hinged and held in place with captive screws of the same finish as the door. The lens and door shall enclose the lamp compartment. The reflector shall be aluminum of the manufacturer's standard commercial product finish suitable for the lamp type and rating. The ballast shall be of the high power factor type. The ballast and power components shall be mounted on a single bracket and shall be removable. The fixture, including the mounting arm, shall be gasketed to allow air movement but prevent the entry of dust and insects. Ballast shall be of the constant wattage autotransformer type for mercury vapor lamps, lead-peak autotransformer type for metal halide lamps, and regulating type for high pressure sodium lamps. Ballast shall be capable of starting and operating the lamp at ambient temperatures ranging from minus 20 degrees F to 105 degrees F. A square extruded aluminum pole including anchor type base, anchor bolts and mounting hardware shall be provided by the fixture manufacturer and shall be the manufacturer's standard commercial product for the number of fixtures and wind load indicated or specified. The fixture housing mounting arm shall have a dark duranodic bronze finish. The fixture shall be prewired and shall have a mogul base glazed porcelain lampholder.

Fixture types indicated on this sheet shall also conform to requirements specified and indicated in the contract documents.



TYPE 501



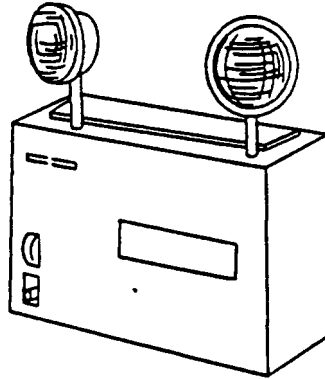
TYPE 502

High Intensity Discharge Fixture for Exterior Wall Mounting,  
Medium Output

Suffix	Description
	Rated for:
A	50 watt high pressure sodium lamp
B	70 watt high pressure sodium lamp
C	100 watt high pressure sodium lamp
D	150 watt high pressure sodium lamp
E	175 watt metal halide lamp

Fixture shall conform to UL 1572 and shall be rated for use in wet locations. The fixture housing, door assembly, and backplate shall be die-cast aluminum. The door assembly shall have integral cast aluminum hinges. The door assembly shall be held securely to the fixture housing with a stainless steel safety strap when the door is in the open position. The door assembly shall be held firmly against a sealing gasket between the fixture door and housing by stainless steel latches or with stainless steel or brass captive screws when the fixture door is closed. The refractor shall be prismatic borosilicate glass or polycarbonate resin. The refractor shall be gasketed and securely held in the door frame, but shall be easily removed for replacement with a common tool. The reflector shall be aluminum with the manufacturer's standard commercial product finish suitable for the type and rating of the lamp. The fixture shall have manufacturers standard protective coating. Cast knockouts shall be provided in the backplate for recessed outlet box mounting. Ballast shall be of the high power factor type. Ballast shall be of the lead-peak autotransformer type for metal halide lamps and the regulating type for high pressure sodium lamps. Ballast shall be capable of starting and operating the lamp at ambient temperatures from minus 20 degrees F to 105 degrees F. The fixture shall be prewired, and shall have a field adjustable, mogul base glazed porcelain lampholder.

Fixture type indicated on this sheet shall also conform to requirements specified and indicated in the contract documents.

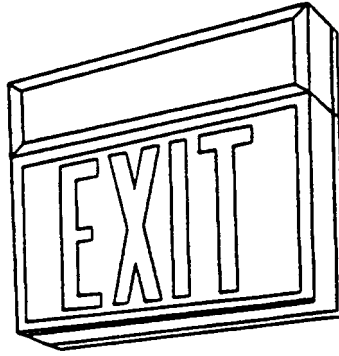


TYPE 603

#### 6-Volt Emergency Battery Pack Unit with Two Floodlights

Unit shall conform to UL 924, and shall meet or exceed the NFPA 70 time and voltage requirements. The unit shall be dual-rated for use on either 120-Volt or 277-Volt alternating current power supplies. Following sustained loss of the normal power supply, the unit shall be capable of automatically and instantaneously illuminating the two 6-Volt lighting fixtures for a period of not less than 90 minutes at a battery voltage in excess of 87.5 percent of the nominal voltage rating. A battery low-voltage cutout or disconnect feature shall be incorporated into the unit to protect the battery against damage if the battery voltage falls below 87.5 percent of the normal battery voltage. The battery shall be the nickel-cadmium, pocket plate type designed to be maintenance free during the expected battery life, and shall be warranted for not less than 3 years from the date of the purchase of the unit, and shall be field replaceable without requiring removal of other components. The battery charger shall be the solid-state type and shall provide a continuous, variable, current limited, filtered and regulated charge rate. The battery and charger shall be contained in a steel cabinet not less than 18 gauge thickness with an enamel finish, unless otherwise approved, which shall be equipped with a push-to-test switch and a meter to indicate battery voltage when the switch is closed. Mounting brackets or shelf shall be provided, complete with all mounting hardware, all with a finish to match the finish or color of the cabinet. The unit shall be prewired and equipped with two 6-volt, 5-8 watt floodlights as indicated.

Fixture types indicated on this sheet shall also conform to requirements specified and indicated in the contract documents.



TYPE 604

Exit Sign With Self-Contained Emergency Battery		
First Suffix	Second Suffix	Description
A		Single face
B		Double face
	1	End mounted
	2	Top mounted
	3	Back mounted
	4	Stem mounted

Unit shall conform to UL 924, and shall meet or exceed the NFPA 70 time and voltage requirements. The unit shall be dual-rated for use on either 120-Volt or 277-Volt alternating current power supplies. Following sustained loss of the normal power supply, the unit shall be capable of automatically and instantaneously illuminating the two 6-Volt lighting fixtures for a period of not less than 90 minutes at a battery voltage in excess of 87.5 percent of the nominal voltage rating. A battery low-voltage cutout or disconnect feature shall be incorporated into the unit to protect the battery against damage if the battery voltage falls below 87.5 percent of the normal battery voltage. The battery shall be the nickel-cadmium, pocket plate type designed to be maintenance free during the expected battery life, and shall be warranted for not less than 3 years from the date of the purchase of the unit, and shall be field replaceable without requiring removal of other components. The battery charger shall be the solid-state type and shall provide a continuous, variable, current limited, filtered and regulated charge rate. The battery and charger shall be contained in a steel cabinet not less than 18 gauge thickness with an enamel finish, unless otherwise approved, which shall be equipped with a push-to-test switch and a meter to indicate battery voltage when the switch is closed. Mounting brackets or shelf shall be provided, complete with all mounting hardware, all with a finish to match the finish or color of the cabinet. All ferrous metal parts shall receive a rust inhibitive coating before application of the finish coat. The fixture shall have a light-emitting diode pilot light to show that the battery charger is functioning. Fixture shall be prewired, with wiring concealed in the illuminated portion of the fixture housing.

Fixture types indicated on this sheet shall also conform to requirements specified and indicated in the contract documents.

## SECTION 16528

## EXTERIOR LIGHTING INCLUDING SECURITY AND CCTV APPLICATIONS

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS  
(AASHTO)

AASHTO LTS-2 (1985; Rev 1986, 1987, 1988) Standard  
Specifications for Structural Supports for  
Highway Signs, Luminaires and Traffic Signals

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C2	(1993) National Electrical Safety Code
ANSI C78.1	(1991; C78.1a) Fluorescent Lamps - Rapid- Start Types - Dimensional and Electrical Characteristics
ANSI C78.1350	(1990) 400-Watt, 100-Volt, S51 Single-Ended High-Pressure Sodium Lamps
ANSI C78.1351	(1989) 250-Watt, 100-Volt S50 Single-Ended High-Pressure Sodium Lamps
ANSI C78.1352	(1990) 1000-Watt, 250-Volt, S52 Single-Ended High-Pressure Sodium Lamps
ANSI C78.1355	(1989) 150-Watt, 55-Volt S55 High-Pressure Sodium Lamps
ANSI C80.1	(1990) Rigid Steel Conduit - Zinc Coated
ANSI C82.4	(1992) Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple- Supply Type)
ANSI C119.1	(1986) Sealed Insulated Underground Connector Systems Rated 600 Volts
ANSI C135.1	(1979) Galvanized Steel Bolts and Nuts for Overhead Line Construction
ANSI C135.14	(1979) Staples with Rolled or Slash Points for Overhead Line Construction
ANSI C136.2	(1985) Luminaires Voltage Classification

ANSI C136.3	(1989) Luminaire Attachments - for Roadway Lighting Equipment
ANSI C136.6	(1990) Roadway Lighting Equipment - Metal Heads and Reflector Assemblies - Mechanical and Optical Interchangeability
ANSI C136.9	(1990) Roadway Lighting Equipment - Socket Support Assemblies for Metal Heads - Mechanical Interchangeability
ANSI C136.10	(1988) Locking-type Photocontrol Devices and Mating Receptacles - Physical and Electrical Interchangeability and Testing for Roadway Lighting Equipment
ANSI C136.11	(1988) Multiple Sockets for Roadway Lighting Equipment
ANSI C136.13	(1992) Metal Brackets for Wood Poles
ANSI C136.15	(1986) High-Intensity-Discharge and Low-Pressure Sodium Lamps in Luminaires - Field Identification

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36	(1994a) Carbon Structural Steel
ASTM A 123	(1989a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153	(1982; R 1987) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 575	(1989) Steel Bars, Carbon, Merchant Quality, M-Grades
ASTM A 576	(1990b) Steel Bars, Carbon, Hot-Wrought, Special Quality
ASTM B 2	(1988) Medium-Hard-Drawn Copper Wire
ASTM B 8	(1993) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B 117	(1994) Operating Salt Spray (Fog) Testing Apparatus
ASTM D 1654	(1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments

## ILLUMINATING ENGINEERING SOCIETY OF NORTH AMERICA (IESNA)

IESNA ARP-8	(1983) Roadway Lighting
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## INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE Std 81 (1983) Guide for Measuring Earth Resistivity,  
Ground Impedance, and Earth Surface  
Potentials of a Ground System

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (1991) Enclosures for Electrical Equipment  
(1000 Volts Maximum)

NEMA ICS 1 (1993) Industrial Controls and Systems

NEMA ICS 2 (1993) Industrial Control Devices,  
Controllers and Assemblies

NEMA ICS 6 (1993) Enclosures for Industrial Control and  
Systems

NEMA OS 1 (1989) Sheet-Steel Outlet Boxes, Device  
Boxes, Covers, and Box Supports

NEMA OS 2 (1986; Errata Aug 1986; R 1991) Nonmetallic  
Outlet Boxes, Device Boxes, Covers and Box  
Supports

NEMA RN 1 (1989) Polyvinyl-Chloride (PVC) Externally  
Coated Galvanized Rigid Steel Conduit and  
Intermediate Metal Conduit

NEMA TC 6 (1990) PVC and ABS Plastic Utilities Duct for  
Underground Installation

NEMA TC 9 (1990) Fittings for ABS and PVC Plastic  
Utilities Duct for Underground Installation

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (1993) National Electrical Code

## UNDERWRITERS LABORATORIES (UL)

UL 6 (1993) Rigid Metal Conduit

UL 98 (1994; Rev Feb 1995) Enclosed and Dead-Front  
Switches

UL 467 (1993) Grounding and Bonding Equipment

UL 486A (1991; Rev Oct 1991) Wire Connectors and  
Soldering Lugs for Use with Copper Conductors

UL 486B (1991; Rev thru Apr 1992) Wire Connections  
for Use with Aluminum Conductors

UL 514A (1991) Metallic Outlet Boxes

UL 514B	(1992; Rev thru Apr 1995) Fittings for Conduit and Outlet Boxes
UL 514C	(1988; Rev Apr 1995) Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL 651	(1989; Rev thru Dec 1989) Schedule 40 and 80 Rigid PVC Conduit
UL 651A	(1989; Rev thru Dec 1989) Type EB and A Rigid PVC Conduit and HDPE Conduit
UL 886	(1994; Rev thru Jul 1995) Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations
UL 870	(1991) Wireways, Auxiliary Gutters, and Associated Fittings
UL 1029	(1994) High-Intensity-Discharge Lamp Ballasts
UL 1571	(1991; Rev thru Jul 1994) Incandescent Lighting Fixtures
UL 1572	(1991; Rev thru Jul 1994) High Intensity Discharge Lighting Fixtures

## 1.2 SYSTEM DESCRIPTION

### 1.2.1 Lighting System

The lighting system shall be configured as specified and shown. The system shall include all fixtures, hardware, poles, cables, connectors, adapters and appurtenances needed to provide a fully functional lighting system.

### 1.2.2 Electrical Requirements

The equipment shall operate from a voltage source as shown, plus or minus 10 percent, and 60 Hz, plus or minus 2 percent.

### 1.2.3 Nameplates

Each major component of equipment shall have a nonferrous metal or engraved plastic nameplate which shall show, as a minimum, the manufacturer's name and address, the catalog or style number, the electrical rating in volts, and the capacity in amperes or watts.

### 1.2.4 Standard Products

Materials and equipment shall be standard products of manufacturer regularly engaged in the manufacture of such products. Items of equipment shall essentially duplicate equipment that has been in satisfactory use at least 2 years prior to bid opening.



### 1.3 CORROSION PROTECTION

#### 1.3.1 Aluminum Materials

Aluminum shall not be used in contact with earth or concrete. Where aluminum conductors are connected to dissimilar metal, fittings conforming to UL 486B shall be used.

#### 1.3.2 Ferrous Metal Materials

##### 1.3.2.1 Hardware

Ferrous metal hardware shall be hot-dip galvanized in accordance with ASTM A 153 and ASTM A 123.

##### 1.3.2.2 Equipment

Equipment and component items, including but not limited to metal poles and ferrous metal luminaires not hot-dip galvanized or porcelain enamel finished, shall be provided with corrosion-resistant finishes which shall withstand 120 hours of exposure to the salt spray test specified in ASTM B 117 without loss of paint or release of adhesion of the paint primer coat to the metal surface in excess of 1.6 mm from the test mark. The scribed test mark and test evaluation shall have a rating of not less than 7 in accordance with TABLE 1, (procedure A) of ASTM D 1654. Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill galvanized sheet steel shall be coated with a zinc rich paint conforming to the manufacturer's standard.

#### 1.3.3 Finishing

Painting required for surfaces not otherwise specified and finish painting of items only primed at the factory, shall be as specified in Section 09900 PAINTING, GENERAL.

### 1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with section 01300 SUBMITTAL PROCEDURES:

#### SD-01 Data

Equipment and Materials; GA.

Data published by the manufacturer of each item on the list of equipment and material, to permit verification that the item proposed is of the correct size, properly rated or applied, or is otherwise suitable for the application and fully conforms to the requirements specified.

Spare Parts; FIO.

Spare parts data for each item of material and equipment specified, after approval of detail drawings for materials and equipment, and not later than 4 months before the date of beneficial occupancy. The data shall include a

complete list of parts, special tools, and supplies, with current unit prices and sources of supply.

#### SD-04 Drawings

Lighting System; GA.

Detail drawings for the complete system and for poles, lighting fixtures, and bracket arms. Drawings shall indicate bonding method for concrete encasement.

As-Built Drawings; GA.

Final as-built drawings shall be finished drawings on mylar or vellum and shall be delivered with the final test report.

#### SD-09 Reports

Operating Test; FIO.

Test procedures and reports for the Operating Test. After receipt by the Contractor of written approval of the test procedures, the Contractor shall schedule the tests. The final test procedures report shall be delivered after completion of the tests.

Ground Resistance Measurements; FIO.

The measured resistance to ground of each separate grounding installation, indicating the location of the rods, the resistance of the soil in ohms per millimeter and the soil conditions at the time the measurements were made. The information shall be in writing.

#### SD-19 Operation and Maintenance Manuals

Lighting System; FIO.

A draft copy of the operation and maintenance manuals, prior to beginning the tests for use during site testing. Final copies of the manuals as specified bound in hardback, loose-leaf binders, within 30 days after completing the field test. The draft copy used during site testing shall be updated with any changes required, prior to final delivery of the manuals. Each manual's contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of each subcontractor installing equipment and systems, and nearest service representatives for each item of equipment for each system. The manuals shall have a table of contents and tab sheets. Tab sheets shall be placed at the beginning of each chapter or section and at the beginning of each appendix. The final copies delivered after completion of the field test shall include modifications made during installation checkout and acceptance.

## 2 PRODUCTS

### 2.1 STANDARD PRODUCT

Material and equipment shall be the standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years

prior to bid opening. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

## 2.2 BRACKET ARMS

### 2.2.1 On Aluminum, Steel, Fiberglass, and Concrete Poles

Poles shall be provided with bracket arms of the support arm style and of the length indicated on drawings. Bracket arms shall conform to the design of the pole provided. The bracket arms shall be capable of supporting the equipment to be mounted on it with the maximum wind and ice loading encountered at the site. Strength of bracket arms shall be in accordance with ANSI C136.13. Steel brackets shall be galvanized. Wood bracket arms shall not be used.

## 2.3 CABLE

The Contractor shall provide all wire and cable not indicated as government furnished equipment. Wire and cable components shall be able to withstand the jobsite environment for a minimum of 20 years.

### 2.3.1 Bare Copper Conductors

Medium-hard-drawn copper conductors shall conform to ASTM B 2 and ASTM B 8.

## 2.4 CABLE SPLICES AND CONNECTORS

Cable splices and connectors shall conform to UL 486A. Underground splices and connectors shall also conform to the requirements of ANSI C119.1.

## 2.5 CABLE BOXES

Boxes and covers shall be made of cast iron with zinc coated or aluminized finish, and shall be of the sizes indicated on drawings. The minimum inside dimensions shall be not less than 304.8 mm square by 152.4 mm deep and not less than required to house the cable splice. A suitable gasket shall be installed between the box and cover for watertightness. A sufficient number of screws shall be installed to hold the cover in place along the entire surface of contact. Grounding lugs shall be provided.

## 2.6 CONDUIT, DUCTS AND FITTINGS

### 2.6.1 Conduit, Rigid Steel

Rigid steel conduit shall conform to ANSI C80.1 and UL 6.

### 2.6.2 Conduit Coatings

Underground metallic conduit and fittings shall be coated with a plastic resin system conforming to NEMA RN 1, Type 40. Epoxy systems may also be used.

### 2.6.3 Conduit Fittings and Outlets

#### 2.6.3.1 Boxes, Metallic Outlets

NEMA OS 1 and UL 514A.

#### 2.6.3.2 Boxes, Nonmetallic, Outlet and Flush-Device Boxes and Covers

NEMA OS 2 and UL 514C.

#### 2.6.3.3 Boxes, Outlet for Use in Hazardous (Classified) Locations

UL 886.

#### 2.6.3.4 Boxes, Switch (Enclosed), Surface Mounted

UL 98.

#### 2.6.3.5 Fittings for Conduit and Outlet Boxes

UL 514B.

#### 2.6.3.6 Fittings for Use in Hazardous (Classified) Locations

UL 886.

#### 2.6.3.7 Fittings, PVC, for Use with Rigid PVC Conduit and Tubing

UL 514B.

#### 2.6.4 Non-Metallic Duct

Non-metallic duct lines and fittings utilized for underground installation shall be suitable for the application. Duct shall be thick-wall, single, round-bore type. Material of one type shall be used. Acrylonitrile-butadiene-styrene (ABS) duct shall conform to NEMA TC 6 and NEMA TC 9. High-density conduit shall conform to UL 651A. Schedule 40 polyvinyl chloride (PVC) shall conform to UL 651. Plastic utility duct and fittings manufactured without a UL label or listing shall be provided with a certification as follows: "The materials are suitable for use with 75 degree C (167 degrees F) wiring. No reduction of properties in excess of that specified for materials with a UL label or listing will be experienced if samples of the finished product are operated continuously under the normal conditions that produce the highest temperature in the duct."

#### 2.7 GROUND RODS

Ground rods shall be of copper clad steel conforming to UL 467 not less than 19.1 mm in diameter by 3.1 m in length of the sectional type driven full length into earth.

#### 2.8 POLES

Metal and concrete poles shall be the pole manufacturer's standard design for supporting the number of fixtures indicated. Poles shall be designed for a wind velocity of 35.8 meters per second (80 mph at the base of the pole, for a wind gust factor of 1.3, and for the height and drag factors recommended by AASHTO LTS-2. The effective projected area of luminaires and other pole-mounted devices shall be taken into account in pole design. Poles shall have grounding provisions. The type of pole shaft material provided shall not be mixed on any project. Grounding connection shall be

provided near the bottom of each metal pole and at each concrete pole anchor base. Scratched, stained, chipped, or dented poles shall not be installed.

#### 2.8.1 Aluminum Poles

Aluminum poles and brackets for walkway lighting shall have a dark anodic bronze finish to match fixtures and shall not be painted. Manufacturer's standard provision shall be made for protecting the finish during shipment and installation. Minimum protection shall consist of spirally wrapping each pole shaft with protective paper secured with tape, and shipping small parts in boxes.

- a. Shafts shall be round and of seamless construction. The wall thickness shall be at least 4.8 mm. Exterior surfaces shall be free of protuberances, dents, cracks, and discoloration. Material for shafts shall be 6063 aluminum alloy; after fabrication, the alloy shall have a T6 temper. Tops of shafts shall be fitted with a round or tapered cover. Bases shall be anchor bolt mounted, made of cast aluminum alloy 356-T6, and shall be machined to receive the lower end of shafts. Joints between shafts and bases shall be welded. Bases shall be provided with four holes, spaced 90 degrees apart, for anchorage.
- b. Hardware, except anchor bolts, shall be either 2024-T4 anodized aluminum alloy or stainless steel.

#### 2.8.2 Steel Poles

Steel poles shall be hot-dip galvanized in accordance with ASTM A 123 and shall not be painted. Poles shall have tapered tubular members, either round in cross-section or polygonal. Pole shafts shall be one piece. Poles shall be welded construction with no bolts, rivets, or other means of fastening except as specifically approved. Pole markings shall be approximately 900 to 1270 mm above grade and shall include manufacturer, year of manufacture, top and bottom diameters, length, and a loading tree. Attachment requirements shall be provided as indicated, including grounding provisions. Climbing facilities are not required. Bases shall be of the anchor bolt-mounted type.

#### 2.8.3 Anchor Bolts

Anchor bolts shall be the pole manufacturer's standard, but not less than necessary to meet the pole wind and ice loading, herein and other specified design requirements.

#### 2.9 POLE LINE HARDWARE

Zinc coated hardware shall conform to ANSI C135.1 and ANSI C135.14, and steel hardware material shall conform to ASTM A 575 and ASTM A 576. Hardware shall be hot-dip galvanized in accordance with ASTM A 153.

#### 2.10 SERIES ROADWAY LIGHTING INSULATORS

Pin insulators shall be Class 55-5. Line-post insulators shall be Class 57-1 or 57-11.

### 2.10.1 Interior Enclosures

Enclosures to house lighting equipment in an interior environment shall meet the requirements of a NEMA 12 enclosure as defined in NEMA 250.

### 2.10.2 Exposed-to-Weather Enclosures

Enclosures to house lighting equipment in an outdoor environment shall meet the requirements of a NEMA 4 enclosure as defined in NEMA 250.

### 2.10.3 Corrosion Resistant Enclosures

Enclosures to house lighting equipment in a corrosive environment shall meet the requirements of a NEMA 4X enclosure as defined in NEMA 250.

## 2.11 ILLUMINATION

### 2.11.1 General Lighting

Luminaires, ballasts, lamps, and control devices required for general area lighting, including floodlighting shall be in accordance with sheets 51 and 56 of Standard Detail No. 40-06-04, attached to these specifications.

## 2.12 LAMPS AND BALLASTS, HIGH INTENSITY DISCHARGE (HID) SOURCES

### 2.12.1 High-Pressure Sodium

Lamps shall conform to ANSI C78.1350 or ANSI C78.1351 or ANSI C78.1352 or ANSI C78.1355. Ballasts shall conform to ANSI C82.4, or UL 1029. High-pressure sodium lamps shall be clear.

## 2.13 LUMINAIRE COMPONENTS

Luminaire components shall conform to the following: attachments, ANSI C136.3; voltage classification, ANSI C136.2; field identification marking, ANSI C136.15; interchangeability, ANSI C136.6 and ANSI C136.9; and sockets, ANSI C136.11.

## 2.14 LIGHTING CONTROL EQUIPMENT

### 2.14.1 Photo-Control Devices

Photo-control devices shall conform to ANSI C136.10. Each photo-control element shall be a replaceable, weatherproof, plug-in or twist-lock assembly adjustable operation range of approximately 5.4 to 53.8 lux. Luminaires shall be equipped with weatherproof plug-in or twist-lock receptacle to receive the photo-control element.

### 2.14.2 Magnetic Contactor

Magnetic contactors shall be mechanically held, electrically operated, and shall conform to NEMA ICS 1 and NEMA ICS 2. The contactor shall be as shown on drawings. Coil voltage shall be as indicated. Maximum continuous ampere rating and number of poles shall be as indicated on drawings. Enclosures for contactors mounted indoors shall be NEMA ICS 6, Type 1. Each contactor shall be provided with a spare, normally open auxiliary contact. Terminal lugs shall be coordinated with the wire size.

## 2.15 PHOTOMETRIC DISTRIBUTION CLASSIFICATION

Photometrics shall conform to IESNA ARP-8.

## 2.16 LUMINAIRES, FLOODLIGHTING

### 2.16.1 HID and Incandescent

HID lighting fixtures shall conform to UL 1572. Incandescent lighting fixtures shall conform to UL 1571.

### 2.16.2 Fluorescent

Fluorescent lamps shall conform to ANSI C78.1.

## 2.17 FIXTURES

Standard fixtures shall be as detailed on Standard Detail No. 40-06-04, Sheet Nos. 51 and 56 which accompany and form a part of this specification. Special fixtures shall be as indicated on the drawings. Illustrations shown on these sheets or on the drawings are indicative of the general type desired and are not intended to restrict selection to fixtures of any particular manufacturer. Fixtures of similar design, equivalent light distribution and brightness characteristics, equal finish and quality will be acceptable as approved.

### 2.17.1 Accessories

Accessories such as straps, mounting plates, nipples, or brackets shall be provided for proper installation.

### 2.17.2 In-Line Fuse

An in-line fuse shall be provided for each fixture, and shall consist of a fuse and a UL approved waterproof fuse holder rated as indicated, with insulated boots. Fuse rating shall be as indicated.

## 2.18 WIREWAY, RAINLIGHT, SUPPORT

Raintight wireway shall conform to UL 870.

## 3 EXECUTION

### 3.1 GENERAL

The Contractor shall install all system components, including government furnished equipment, and appurtenances in accordance with the manufacturer's instructions, ANSI C2, and contract documents, and shall furnish necessary hardware, fixtures, cables, wire, connectors, interconnections, services, and adjustments required for a complete and operable system.

#### 3.1.1 Current Site Conditions

The Contractor shall verify that site conditions are in agreement with the design package. The Contractor shall report all changes to the site or conditions that will affect performance of the system to the Government.

The Contractor shall not take any corrective action without written permission from the Government.

### 3.1.2 Existing Equipment

The Contractor shall connect to and utilize existing lighting equipment and devices as shown. Lighting equipment that is usable in their original configuration without modification may be reused with Government approval. The Contractor shall perform a field survey, including testing and inspection of existing lighting equipment and control lines intended to be incorporated into the lighting system, and furnish a report to the Government. For those items considered nonfunctioning, specification sheets, or written functional requirements to support the findings and the estimated cost to correct the deficiency shall be provided with the report. As part of the report, the Contractor shall include the scheduled need date for connection to all existing equipment. The Contractor shall make written requests and obtain approval prior to disconnecting any control lines and equipment, and creating equipment downtime. Such work shall proceed only after receiving Government approval of these requests. If any device fails after the Contractor has commenced work on that device, the Contractor shall diagnose the failure and perform any necessary corrections to the equipment. The Government is responsible for maintenance and repair of Government equipment. The Contractor shall be held responsible for repair costs due to Contractor negligence or abuse of Government equipment.

### 3.2 ENCLOSURE PENETRATIONS

Enclosure penetrations shall be from the bottom unless the system design requires penetrations from other directions. Penetrations of interior enclosures involving transitions of conduit from interior to exterior, and penetrations on exterior enclosures shall be sealed with rubber silicone sealant to preclude the entry of water. The conduit riser shall terminate in a hot-dipped galvanized metal cable terminator. The terminator shall be filled with an approved sealant as recommended by the cable manufacturer, and in such a manner that the cable is not damaged.

### 3.3 PREVENTION OF CORROSION

#### 3.3.1 Aluminum

Aluminum shall not be used in contact with earth or concrete, and where connected to dissimilar metal, shall be protected by approved fittings and treatment.

#### 3.3.2 Steel Conduits

Steel conduits shall not be installed within concrete slabs-on-grade. Steel conduits installed underground or under slabs-on-grade, or penetrating slabs-on-grade, shall be field wrapped with 254 micrometers (0.010 inch) thick pipe-wrapping plastic tape applied with a 50 percent overlap, or shall have a factory-applied plastic resin, epoxy coating. Zinc coating may be omitted from steel conduit which has a factory-applied epoxy coating.



### 3.3.3 Cold Galvanizing

Field welds and/or brazing on factory galvanized boxes, enclosures, conduits, etc. shall be coated with a cold galvanized paint containing at least 95 percent zinc by weight.

## 3.4 CABLE INSTALLATION

Cable and all parts of the cable system such as splices and terminations shall be rated not less than 600 volts. The size and number of conductors and the number of cables shall be as indicated. Conductors larger than No. 8 AWG shall be stranded. Each circuit shall be identified by means of fiber or nonferrous metal tags, or approved equal, in each junction box, and at each terminal.

### 3.4.1 Splices

Splices below grade shall be made with nonpressure-filled resin systems using transparent, interlocking, self-venting, longitudinally split plastic molds. Splices above grade shall be made with sealed insulated pressure connectors and shall provide insulation and jacket equal to that of the cable. In order to prevent moisture from entering the splice, jackets shall be cut back to expose the required length of insulation between the jacket and the tapered end of the insulation.

### 3.4.2 Installation in Duct Lines

Ground and neutral conductors shall be installed in duct with the associated phase conductors. Cable splices shall be made in handholes only.

### 3.4.3 Direct Burial

Minimum cover from top of cable to finished grade shall be 750 mm for direct buried cable, but not less than the depth of the frost line.

#### 3.4.3.1 Trenching

Trenches shall be excavated to the depths required to provide the minimum cable cover. The bottom of the trench shall be smooth and free of stones and sharp objects. Where the bottom of the trench consists of material other than sand or earth, an additional 75 mm layer shall be removed and replaced by a 75 mm layer of sand or stone-free earth compacted to the approximate density of the surrounding firm soil. The cables shall be unreeled in place along the side of or in the trench and carefully placed on the sand or earth bottom. Pulling cables into a direct-burial trench from a fixed reel position will not be permitted. Where cables cross, a separation of at least 75 mm shall be provided, unless the cables are protected by nonmetallic conduit sleeves at the crossing. The radius of bends in cables shall be not less than 12 times the diameter of the cable. Cables shall not be left under longitudinal tension. The first layer of backfill shall be 150 mm thick and shall consist of sand or stone-free earth. One-inch untreated planks, not less than 200 mm in width, or approved equal protection, shall be placed end to end along the cable run, approximately 75 mm above the cable. A 0.127 mm, brightly colored plastic tape not less than 75 mm in width and suitably inscribed at not more than 3 m on centers, or other approved dig-in warning indication, shall be placed approximately 300

mm below finished grade levels of trenches. Selected backfill of sand or stone-free earth shall be provided to a minimum depth of 75 mm above cables.

#### 3.4.3.2 Requirements for Installation in Duct

Where indicated on drawing, cable shall be installed in duct lines. Ground and neutral conductors shall be installed in duct with the associated phase conductors. The segments of direct-burial cable that cross under new railroad tracks, roads, or paving exceeding 1.5 m in width, shall be installed in plastic, or rubber duct encased in concrete in accordance with paragraph DUCT LINES. Pulling of cable into conduit from a fixed reel position will be permitted. At interfaces with direct-burial cable, the direct-burial cable shall be centered in the entrance to the duct, using an approved waterproof, nonhardening mastic compound to facilitate the centering. Where crossing existing railroad tracks, coated rigid steel conduit shall be installed under the tracks, in lieu of concrete-encased duct, in accordance with paragraph DUCT LINES. Installation shall be in accordance with NFPA 70 and the regulations of the railroad.

#### 3.4.3.3 Location of Cable Splices

Splices in direct-burial cable will not be permitted in runs of 150 m or less or at intervals of less than 150 m in longer runs except as required for taps. Where cable splices in shorter intervals are required to avoid obstructions or damage to the cable, the location shall be as approved. Cable splices shall be installed in cable boxes.

#### 3.4.3.4 Markers

Cable and cable splice markers shall be located near the ends of cables, at each cable splice, approximately every 120 m along the cable run, and at changes in direction of the cable run. Markers need not be placed along cables laid in relatively straight lines between lighting poles that are spaced less than 120 m apart. Markers shall be placed approximately 600 mm to the right of the cable or cable splice when facing the longitudinal axis of the cable in the direction of the electrical load. The marker shall be concrete with a 28 day compressive strength of 17 MPa in accordance with Section 03300 CONCRETE FOR BUILDING CONSTRUCTION. The letter "C" shall be impressed in the top of each marker.

#### 3.4.3.5 Warning Tape

Direct burial cable shall be placed below a plastic warning tape buried in the same trench or slot. A 0.127 mm brightly colored plastic tape, not less than 75 mm in width and suitably inscribed at not more than 3 m on centers with a continuous metallic backing and a corrosion-resistant 0.0254 mm metallic foil core to permit easy location of the buried cable, shall be placed approximately 300 mm below finished grade.

#### 3.4.3.6 Ground Resistance Testing

The resistance to ground shall be measured using the fall-of-potential method described in IEEE Std 81. The maximum resistance shall not exceed 25 ohms under normally dry conditions. Whenever the required ground resistance is not met, additional electrodes shall be provided as indicated, to achieve the specified ground resistance. The additional electrodes shall be up to three rods each 3 m long and spaced a minimum of 3 m apart a single

extension-type rod, 19.1 mm diameter, up to 9.1 m long, driven perpendicular to grade. In high ground resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, the Contracting Officer shall be notified immediately.

### 3.5 CONNECTIONS TO BUILDINGS

Cables shall be extended into the various buildings as indicated and shall be properly connected to the indicated equipment. After installation of cables, conduits shall be sealed to prevent moisture or gases from entering the building.

### 3.6 DUCT LINES

#### 3.6.1 Requirements

Numbers and size of ducts shall be as indicated. Duct lines shall be laid with a minimum slope of 100 mm per 30 m. Depending on the contour of the finished grade, the high point may be at a terminal. Short radius manufactured 90 degree duct bends may be used only for pole or equipment risers, unless specifically indicated as acceptable. The minimum manufactured bend radius shall be 450 mm for ducts of less than 80 mm in diameter, and 900 mm for duct 80 mm or greater in diameter. Otherwise, long sweep bends having a minimum radius of 7.6 m shall be used for a change of direction of more than 5 degrees, either horizontally or vertically. Both curved and straight sections may be used to form long sweep bends, but the maximum curve used shall be 30 degrees and manufactured bends shall be used.

#### 3.6.2 Treatment

Ducts shall be kept clean of concrete, dirt, or foreign substances during construction. Field cuts requiring tapers shall be made with proper tools and shall match factory tapers. A coupling recommended by the duct manufacturer shall be used when an existing duct is connected to a duct of different material or shape. Ducts shall be stored to avoid warping and deterioration with ends sufficiently plugged to prevent entry of any water or solid substances. Ducts shall be thoroughly cleaned before being laid. Plastic ducts shall be stored on a flat surface and protected from the direct rays of the sun.

#### 3.6.3 Nonencased Direct-Burial

Top of duct lines shall be below the frost line, but not less than 600 mm below finished grade and shall be installed with a minimum of 75 mm of earth around each duct, except that between adjacent electric power and communication ducts, 300 mm of earth is required. Bottom of trenches shall be smooth and free of stones, soft spots, and sharp objects. Where bottoms of trenches comprise materials other than sand, a 75 mm layer of sand shall be laid first and compacted to approximate densities of surrounding firm soil before installing ducts. Joints in adjacent tiers of duct shall be vertically staggered at least 150 mm. The first 150 mm layer of backfill cover shall be sand compacted as previously specified. The rest of the excavation shall be backfilled and compacted in 75 to 150 mm layers. Duct banks may be held in alignment with earth. However, high tiered banks shall use a wooden frame or equivalent form to hold ducts in alignment prior to backfilling.

### 3.6.4 Installation of Couplings

Joints in each type of duct shall be made up in accordance with the manufacturer's recommendation for the particular type of duct and coupling selected and as approved.

#### 3.6.4.1 Plastic Duct

Duct joints shall be made by brushing a plastic solvent on insides of plastic coupling fittings and on outsides of duct ends. Each duct and fitting shall then be slipped together with a quick 1/4 turn to set the joint tightly.

#### 3.6.5 Concrete

Concrete work shall be as specified in Section 03300 CONCRETE FOR BUILDING CONSTRUCTION. Concrete shall be plain, 17 MPa at 28 days, except that reinforced concrete shall be 21 MPa at 28 days. Duct line encasement shall be of monolithic construction. Where a connection is made to an existing duct line, the concrete encasement shall be well bonded or doweled to the existing encasement.

#### 3.6.6 Duct Line Markers

Duct line markers shall be provided at the ends of long duct line stubouts or for other duct locations that are indeterminate because of duct curvature or terminations at completely below-grade structures. In addition to markers, a 0.127 mm brightly colored plastic tape, not less than 75 in width and suitably inscribed at not more than 3 m on centers with a continuous metallic backing and a corrosion-resistant 0.0254 mm metallic foil core to permit easy location of the duct line, shall be placed approximately 300 mm below finished grade levels of such lines.

### 3.7 POLE INSTALLATION

Pole lengths shall provide a luminaire mounting height of 9.1 m. Luminaire mounting height may be increased by the height of the transformer base where required. The mount interfaces shall have ac power connected, and the pole wiring harness shall be connected to the luminaire. Light poles shall not be installed outside the site or inside the perimeter zone. Pole installation shall conform to the manufacturer's recommendations, NFPA 70, and ANSI C2. Poles shall be set straight and plumb.

#### 3.7.1 Pole Brackets

Brackets shall be installed as specified by the manufacturer and as shown on drawings. Mounting hardware shall be sized appropriately to secure the mount, luminaire, and housing with wind and ice loading normally encountered at the site. Pole brackets for floodlights shall have the number of tenons indicated, arranged to provide the indicated spread between each tenon. Where indicated on drawings, adjustable heads shall be installed on the brackets to position the luminaires. Identical brackets shall be used with one type of luminaire.

### 3.7.2 Concrete Foundations

Concrete foundations shall have anchor bolts accurately set in the foundation using a template supplied by the pole manufacturer. Once the concrete has cured, the pole shall be set on the foundation, leveled on the foundation bolts, and secured with the holding nuts. The space between the foundation and the pole base shall be grouted. Concrete and grout work shall conform to Section 03300 CONCRETE FOR BUILDING CONSTRUCTION. Concrete shall be 21 MPa at 28 days.

### 3.7.3 Aluminum, Steel, Fiberglass and Concrete Pole Installation

Poles shall be mounted on cast-in-place or power-installed screw foundations. Concrete poles shall be embedded in accordance with the details shown. Conduit elbows shall be provided for cable entrances into pole interiors.

#### 3.7.3.1 Cast-In-Place Foundations

Concrete foundations, sized as indicated, shall have anchor bolts accurately set in foundations using templates supplied by the pole manufacturer. Concrete work and grouting is specified in Section 03300 CONCRETE FOR BUILDING CONSTRUCTION. After the concrete has cured, pole anchor bases shall be set on foundations and leveled by shimming between anchor bases and foundations or by setting anchor bases on leveling nuts and grouting. Poles shall be set plumb. Anchor bolts shall be the manufactures standard, and not less than necessary to meet the pole wind loading and other specified design requirements.

#### 3.7.3.2 Power-Installed Screw Foundations

Power-installed screw foundations having the required strength mounting bolt, and top plate dimensions may be utilized. Screw foundations shall be of at least 6.4 mm thick structural steel conforming to ASTM A 36 and hot-dip galvanized in accordance with ASTM A 123. Conduit slots in screw foundation shafts and top plates shall be marked to indicate orientation. Design calculations indicating adequate strength shall be approved before installation of any screw foundation is permitted.

## 3.8 LIGHTING

### 3.8.1 Lamps

Lamps of the proper type, wattage, and voltage rating shall be delivered to the project in the original containers and installed in the fixtures just before completion of the project.

### 3.8.2 Fixture Installation

Standard fixtures shall be installed as detailed on Standard Detail No. 40-06-04, Sheet Nos. 401, and 502 which accompany and form a part of this specification. Special fixtures shall be as indicated on drawings. Illustrations shown on these sheets or on the drawings are indicative of the general type desired and are not intended to restrict selection of fixtures to any particular manufacturer. Fixtures of similar design, equivalent light-distribution and brightness characteristics, and equal finish and quality will be acceptable as approved.

### 3.8.2.1 Accessories

Accessories such as straps, mounting plates, nipples, or brackets shall be installed as required for proper installation.

### 3.8.2.2 In-Line Fuses

An in-line fuse shall be provided for each fixture.

## 3.9 LIGHTING CONTROL SYSTEM

### 3.9.1 Photo-Control

Lighting luminaires shall be controlled in banks by a single photo-control element mounted within each bank.

### 3.9.2 Magnetic Contactors

Terminal lugs shall be coordinated with the wire size. Switches shall be securely fastened to the supporting structure or wall using not less than four 6.4 mm bolts. The use of sheet metal screws will not be allowed.

## 3.10 GROUNDING

Grounding shall be in conformance with NFPA 70, the contract drawings, and the following. Grounding conductors shall be soft-drawn, stranded copper. Ground rods shall be driven into the earth so that after the installation is complete, the top of the ground rod will be approximately 300 mm below finished grade, except in handholes. Butt grounds made of at least 4 m of No. 6 bare copper wire stapled to the butts of wood poles in spirals may be used where a ground resistance of 25 ohms or less can be obtained by this method.

### 3.10.1 Ground Rods and Pole Butt Electrodes

The resistance to ground shall be measured using the fall-of-potential method described in IEEE Std 81. The maximum resistance of a driven ground rod shall not exceed 25 ohms under normally dry conditions. Whenever the required ground resistance is not met, additional electrodes shall be provided interconnected with grounding conductors, to achieve the specified ground resistance. The additional electrodes shall be up to three, 3 m rods spaced a minimum of 3 m apart a single extension-type rod, 19.1 mm diameter, up to 9.1 m long, driven perpendicular to grade. In high ground resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, the Contracting Officer shall be notified immediately. Connections below grade shall be fusion welded. Connections above grade shall be fusion welded or shall use UL 467 approved connectors.

### 3.10.2 Items to be Grounded

Ground conductors, metallic conduits, junction boxes, and noncurrent-carrying metallic parts of equipment shall be grounded. Connections above grade shall be made with solderless connectors, and those below grade shall be made by a fusion-welding process.

### 3.10.3 Lighting Pole

One ground rod shall be provided at each pole. Bases of metal or concrete lighting poles shall be connected to ground rods by means of No. 8 AWG bare copper wire. Lighting fixture brackets on wood and concrete poles shall be grounded to a No. 6 AWG bare copper grounding conductor connected to the ground rod.

### 3.10.4 Metal Cable Boxes

Metal cable boxes for direct-burial cable shall be connected to adjacent ground rods by wires with current-carrying capacities of at least 20 percent of the spliced phase conductors, but not less than No. 6 AWG.

## 3.11 TESTS

### 3.11.1 Operating Test

After the installation is completed and at such time as the Contracting Officer may direct, the Contractor shall conduct an operating test for approval. The equipment shall be demonstrated to operate in accordance with the requirements specified. The test shall be performed in the presence of the Contracting Officer. The Contractor shall furnish instruments and personnel required for the test, and the Government will furnish the necessary electric power.

### 3.11.2 Ground Resistance Measurements

The resistance to ground shall be measured by the fall-of-potential method described in IEEE Std 81.

The contractor shall maintain a separate set of drawings, elementary diagrams and wiring diagrams of the lighting to be used for "as-built" drawings. This set shall be accurately kept up to date by the Contractor with all changes and additions to the lighting system. In addition to being complete and accurate, this set of drawings shall be kept neat and shall not be used for installation purposes. Upon completion of the as-built drawings, a representative of the Government will review the as-built work with the Contractor. If the as-built work is not complete, the Contractor will be so advised and shall complete the work as required.

## SECTION 16642

## CATHODIC PROTECTION SYSTEM (IMPRESSED CURRENT)

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C80.1 (1990) Rigid Steel Conduit - Zinc Coated

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 418 (1988; R 1993) Cast and Wrought Galvanic Zinc Anodes

ASTM D 1248 (1984; R 1989) Polyethylene Plastics Molding and Extrusion Materials

## NATIONAL ASSOCIATION OF CORROSION ENGINEERS (NACE)

NACE RP0169 (1992) Control of External Corrosion on Underground or Submerged Metallic Piping Systems

NACE RP0188 (1990) Discontinuity (Holiday) Testing of Protective Coatings

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA TC 2 (1990) Electrical Polyvinyl Chloride (PVC) Tubing (EPT) and Conduit (EPC-40 and EPC-80)

NEMA WC 5 (1992; Rev Dec 1993) Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (1996) National Electrical Code

## UNDERWRITERS LABORATORIES (UL)

UL 6 (1993) Rigid Metal Conduit

UL 467 (1993) Grounding and Bonding Equipment

UL 506 (1994; Rev Jul 1994) Specialty Transformers

UL 510 (1994) Insulating Tape

UL 514A (1993; Rev Apr 93) Metallic Outlet Boxes



## 1.2 GENERAL REQUIREMENTS

A complete, operating impressed current cathodic protection system in accordance with NFPA 70, the applicable federal, state and local regulations, and the requirements of this contract shall be provided. The system shall include planning, inspecting the installation, adjusting and testing cathodic protection and test system using rectifiers and impressed current anodes, supplemented with sacrificial anodes as needed, for utilities and equipment shown. The cathodic protection system shall also include cables, connectors, splices, corrosion protection test stations, ac power panels, and any other equipment required for a complete operating system providing the specified protection. The cathodic protection system shall include (a) calculations for rectifier, anodes, and any recommendations for supplementing or changing the minimum design criteria to provide the specified potentials and (b) equipment, wiring, and wiring devices necessary to produce a continuous flow of direct current from anodes in the soil electrolyte to the pipe surfaces. The installation shall meet the specified protection criteria for a 25 year life.

### 1.2.1 Contractor's Modifications

The specified system is based on an impressed current system supplemented with magnesium anodes. The Contractor may modify the cathodic protection system after review of the project, site verification and analysis if the proposed modifications include the impressed current anodes and rectifiers and will provide better overall system performance. The modifications shall be fully described, shall be approved by the Contracting Officer and shall meet the following criteria. The proposed system shall achieve a minimum pipe-to-soil "Instant Off" potential of minus 0.85 volts with reference to a saturated copper-copper sulfate reference cell on the underground components of the piping. The Contractor shall take resistivity measurements of the soil in the vicinity of the pipes and ground bed sites; based upon the measurements taken, the current and voltage of the rectifier shall be adjusted as required to produce a minimum of minus 850 millivolts "Instant Off" potential between the structure being tested and the reference cell. This potential shall be obtained over 95 percent of the metallic area without the "Instant Off" potential exceeding 120 millivolts.

### 1.2.2 Insulators

Insulators are required to insulate the indicated pipes from any other structure. Insulators shall be provided with lightning protection and a test station as shown.

### 1.2.3 Anodes and Bond Wires

Anodes shall be installed in sufficient number and of the required type, size and spacing to obtain a uniform current distribution of 2.5 milliamps per 0.09 square meters minimum to underground metal surfaces. For each cathodic protection system, the metallic components and structures to be protected shall be made electrically continuous. This shall be accomplished by installing bond wires between the various structures. Bonding of existing buried structures may also be required to preclude detrimental stray current effects and safety hazards. Provisions shall be included to return stray current to its source without damaging structures intercepting the stray current. The electrical isolation of underground facilities in

accordance with acceptable industry practice shall be included under this section.

#### 1.2.4 Surge Protection

Approved zinc grounding cells or sealed weatherproof lightning arrestor devices shall be installed across insulated flanges or fittings installed in underground piping as indicated on the drawings. The arrestor shall be gapless, self-healing, solid state type. Zinc anode composition shall conform to ASTM B 418, Type II. Lead wires shall be number 6 AWG copper with high molecular weight polyethylene (HMWPE) insulation. The zinc grounding cells shall not be prepackaged in backfill but shall be installed as detailed on the drawings. Lightning arrestors or zinc grounding cells are not required for insulated flanges on metallic components used on nonmetallic piping systems.

#### 1.2.5 Sacrificial Anodes

Sacrificial high potential magnesium anodes shall be located as required to provide localized cathodic protection or supplemental cathodic protection for the impressed current system. Each sacrificial magnesium anode shall be routed through a test station until the impressed current system has final power adjustment; the magnesium anode shall not be connected to the pipe.

#### 1.2.6 Nonmetallic Pipe Systems

When nonmetallic pipe is approved, direct buried or submerged metallic components of the pipe system shall have cathodic protection. Metallic components are connectors, tees, fire hydrants, valves, short pipes, elbows, tie rods, or other metallic equipment. As a minimum, each metallic component shall be protected with a 4.09 kg magnesium anode connected through a test station. The use of nonmetallic pipe does not change other requirements of the specifications such as submittals, testing, or design calculations for each metallic component. Deviations due to the use of nonmetallic pipe shall be approved by the Contracting Officer.

##### 1.2.6.1 Coatings

Coatings for metallic components shall be as required for metallic fittings. Protective covering (coating and taping) shall be completed and tested on each metallic component and shall be as required for underground metallic pipe.

##### 1.2.6.2 Tracer Wire

When a nonmetallic pipe line is used to extend or add to an existing metallic line, an insulated No. 8 AWG copper wire shall be thermit-welded to the existing metallic line and run the length of the new nonmetallic line. This wire shall be used as a locator tracer wire and to maintain continuity to any future extensions of the pipe line.

#### 1.2.7 Services of Corrosion Engineer

The Contractor shall obtain the services of a corrosion engineer to design, supervise, inspect, and test the installation and performance of the cathodic protection system. Corrosion Engineer refers to a person, who, by reason of his knowledge of the physical sciences and the principles of

engineering and mathematics, acquired by professional education and related practical experience, is qualified to engage in the practice of corrosion control. Such person may be a licensed professional Corrosion Engineer or may be a person certified as being qualified by the National Association of Corrosion Engineers (NACE), if such licensing or certification includes 3 years experience in corrosion control on underground metallic surfaces of the type under this contract. NACE certification shall be technologist, corrosion specialist, or cathodic protection specialist. The corrosion engineer shall make at least 3 visits to the project site. The first of these visits shall include obtaining soil resistivity data, acknowledging the type of pipeline coatings to be used and reporting to the Contractor the type of cathodic protection required. Once the submittals are approved and the materials delivered, the corrosion engineer shall revisit the site to ensure the Contractor understands installation practices and laying out the components. The third visit shall involve testing the installed cathodic protection systems and training applicable personnel on proper maintenance techniques. The corrosion engineer shall supervise installation and testing of all cathodic protection.

### 1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

#### SD-01 Data

Materials and Equipment; GA.

Within 30 days after receipt of notice to proceed, an itemized list of equipment and materials including item number, quantity, and manufacturer of each item. The list shall be accompanied by a description of procedures for each type of testing and adjustment, including testing of coating for thickness and holidays. Installation of materials and equipment shall not commence until this submittal is approved.

Spare Parts; FIO.

Spare parts data for each different item of material and equipment specified, after approval of detail drawings and not later than 2 months prior to the date of beneficial occupancy. The data shall include a complete list of parts, special tools, and supplies, with current unit prices and source of supply. One spare anode of each type shall be furnished.

#### SD-04 Drawings

Cathodic Protection System; GA.

Six copies of detail drawings consisting of a complete list of equipment and material including manufacturer's descriptive and technical literature, catalog cuts, results of system design calculations including soil resistivity, installation instructions and certified test data stating the maximum recommended anode current output density and the rate of gaseous production if any at that current density. Detail drawings shall contain complete wiring and schematic diagrams and any other details required to

demonstrate that the system has been coordinated and will function properly as a unit.

Contractor's Modifications; GA.

Six copies of detail drawings showing proposed changes in location, scope or performance indicating any variations from, additions to, or clarifications of contract drawings. The drawings shall show proposed changes in anode arrangement, anode size and number, anode materials and layout details, conduit size, wire size, mounting details, wiring diagram, method for electrically isolating each pipe, and any other pertinent information to the proper installation and performance of the system.

#### SD-08 Statements

Qualifications; GA.

Evidence of qualifications of the corrosion engineer.

#### SD-09 Reports

Test and Measurements; FIO.

Test reports in booklet form tabulating field tests and measurements performed, upon completion and testing of the installed system and including close interval potential survey, casing and interference tests, final system test verifying protection, insulated joint and bond tests, and holiday coating test. Each test report shall indicate the final position of controls. A certified test report showing that the connecting method has passed a 120-day laboratory test without failure at the place of connection, wherein the anode is subjected to maximum recommended current output while immersed in a 3 percent sodium chloride solution.

Contractor's Modifications; FIO.

Final report regarding supplemental magnesium anode installation. The report shall include pipe-to-soil measurements throughout the affected area, indicating that the additions corrected the conditions which made the additional anodes necessary, and current measurements for the additional anodes. The following special materials and information are required: Calculations on current and voltage for designed voltage rectifier plus rectifier and meters specifications; taping materials and conductors; zinc grounding cell, installation and testing procedures, and equipment; coating material; system design calculations for rectifier, anode number, life, and parameters to achieve protective potential; backfill shield material and installation details showing waterproofing; bonding and waterproofing details; insulated resistance wire; exothermic weld equipment and material.

#### SD-13 Certificates

Cathodic Protection System; FIO.

Proof that the materials and equipment furnished under this section conform to the specified requirements contained in the referenced standards or publications. The label or listing by the specified agency will be acceptable evidence of such compliance.

## SD-19 Operation and Maintenance Manuals

## Cathodic Protection System; GA

Six copies of operating manual outlining the step-by-step procedures required for system startup, operation, adjustment of current flow, and shutdown. The manuals shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Six copies of maintenance manual listing routine maintenance procedures, recommendation for maintenance testing, possible breakdowns and repairs, and troubleshooting guides. The manuals shall include single line diagrams for the system as installed; instructions in making pipe-to-reference cell potential measurements and frequency of monitoring; instructions for dielectric connections, interference and sacrificial anode bonds; instructions shall include precautions to ensure safe conditions during repair of pipe system.

## 2 PRODUCTS

## 2.1 IMPRESSED CURRENT ANODES

## 2.1.1 Bare High Silicon Cast-Iron Anodes

Cast-iron anodes shall be of the size indicated and shall conform to the following requirements:

## 2.1.1.1 Chemical Composition (Nominal)

Element	Percent by Weight Grade 2
Silicon	14.20-14.75
Manganese	1.50 Max.
Carbon	0.75-1.15
Chromium	3.25-5.00
Iron	Balance

## 2.1.1.2 Electrical Resistivity

Seventy-two microhm-centimeter at minus 7 degrees C.

## 2.1.1.3 Physical Properties (Nominal)

Tensile strength	103.4 MPa
Compressive strength	689.5 MPa
Brinell hardness	520
Density	7000 kilograms per cubic meter
Melting point	1260 degrees C
Coefficient of to 100 degree C	132 nanometer per degree C

## 2.1.2 Bare Graphite Anodes

Bare graphite anodes shall have a maximum electrical resistivity of 0.0011 ohm-centimeter.

### 2.1.3 Canister Contained Anodes

Canister contained anodes shall be packed at the factory in sheet metal canisters with calcined petroleum coke breeze or metallurgical coke breeze and the canisters shall be capped with tight fitting end caps secured to the body of the canister. The canister shall provide a minimum annular space of 75 mm all around the anode. The connecting cable shall pass through a hole in an end cap designed to be tight fitting with the cable and protected from sharp edges with a plastic or rubber grommet. The anodes shall be centered in the canisters and the annular space filled with coke breeze compacted in place.

### 2.1.4 Anode Connecting Cables

Anodes shall have connecting cables installed at the factory. For deep well ground bed, each anode located in the well shall be accompanied by a reel of continuous cable having the length indicated. No spliced connections will be permitted in deep well cables.

## 2.2 RECTIFIERS AND ASSOCIATED EQUIPMENT

### 2.2.1 Rectifier Unit

Rectifier unit shall consist of a transformer, rectifying elements, transformer tap adjuster, terminal block, one dc output voltmeter, one dc output ammeter, one toggle switch for each meter, fuse holders with fuses for each dc circuit, variable resistors, an ac power-supply circuit breaker, lightning arresters for both input and output, all wired and assembled in a weatherproof metal cabinet. The overall efficiency of the rectifier shall be not less than 65 percent when operated at nameplate rating and shall be capable of supplying continuous full rated output at an ambient temperature of 44 degrees C in full sunlight with expected life in excess of 10 years.

#### 2.2.1.1 Transformer

Transformer shall conform to UL 506.

#### 2.2.1.2 Rectifiers

Rectifying elements shall be silicon diodes connected to provide full-wave rectification. Silicon diodes shall be protected by selenium surge cells or varistors against over-voltage surges and by current-limiting devices against over-current surges.

#### 2.2.1.3 Meters

Meters shall be accurate to within plus or minus 2 percent of full scale at 27 degrees C, and shall possess temperature stability above and below 27 degrees C of at least 1 percent per 5 degrees C. Separate meters shall be 63.5 mm nominal size or larger.

#### 2.2.1.4 Circuit Breaker

A single-pole, flush-mounted, fully magnetic, properly rated nonterminal type circuit breaker shall be installed in the primary circuit of the rectifier supply transformer.

#### 2.2.1.5 Fuses

Cartridge-type fuses with suitable fuse holders shall be provided in each leg of the dc circuit.

#### 2.2.2 Cabinet Construction

Cabinet shall be constructed of not lighter than 1.56 mm steel, and shall be provided with a full door. The door shall be hinged and have a hasp that will permit the use of a padlock. The cabinet shall be fitted with screened openings of the proper size to provide for adequate cooling. Holes, conduit knockouts, or threaded hubs of sufficient size and number shall be conveniently located.

##### 2.2.2.1 Wiring Diagram

A complete wiring diagram of the power unit showing both the ac supply and the dc connections to anodes shall be on the inside of the cabinet door. All components shall be shown and labeled.

##### 2.2.2.2 Grounding Provisions

Grounding provisions shall comply with NFPA 70 and UL 467 including a grounding terminal in the cabinet. The grounding conductor from the terminal to the earth grounding system shall be solid or stranded copper not smaller than No. 6 AWG. The earth grounding system shall consist of one or more 15.9 mm diameter copper-clad steel rods. Ground rods shall be 2.4 m long minimum.

##### 2.2.2.3 Cabinet Paint System

The cabinet and mounting support shall be hot dipped galvanized stainless steel with the manufacturer's standard painting system.

#### 2.2.3 Wiring

Wiring shall be installed in accordance with NFPA 70 utilizing type TW or RHW or polyethylene insulation. Fittings for conduit and cable work shall conform to UL 514A. Outlets shall be of the threaded hub type with gasketed covers. Conduit shall be hub type with gasketed covers. Conduit shall be securely fastened at 2.4 m intervals or less. Splices shall be made in outlet fittings only. Conductors shall be color coded for identification. Cable for anode header and distribution shall be No. 2 AWG stranded copper wire with type cathodic protection high molecular weight polyethylene.

#### 2.3 COKE BREEZE

##### 2.3.1 Calcined Petroleum Coke Breeze (Dry)

Breeze shall conform to the following requirements:

###### 2.3.1.1 Electrical Resistivity

10 milliohm-meter to 20 milliohm-meter, tightly compacted.

100 milliohm-meter to 150 milliohm-meter, loosely compacted.

#### 2.3.1.2 Bulk Density

768 to 1184 kg per cubic meter.

#### 2.3.2 Metallurgical Coke Breeze (Processed)

Breeze shall conform to the following requirements:

##### 2.3.2.1 Electrical Resistivity (Nominal)

100 milliohm-meter Max., tightly compacted.

100 milliohm-meter to 150 milliohm-meter, lightly compacted.

150 to 200 milliohm-meter, loose.

##### 2.3.2.2 Bulk Density

608 to 672 kg per cubic meter.

#### 2.4 MISCELLANEOUS MATERIALS

##### 2.4.1 Electrical Wire

###### 2.4.1.1 Anode Connecting Wire

Anode connecting wire shall be No. 8 AWG stranded copper wire with type CP high molecular weight polyethylene insulation, 2.8 mm thick, 600 volt rating, in accordance with NEMA WC 5. Cable-to-anode contact resistance shall be 0.003 ohms maximum. Deep anode ground bed connecting wire shall be No. 8 AWG, stranded copper wire with an inner jacket of 1 mm of Halar insulation covered by an outer jacket of 1.6 mm CP high molecular weight polyethylene insulation, 600 volt rating, in accordance with NEMA WC 5. Cable-to-anode contact resistance shall be 0.02 ohms maximum.

###### 2.4.1.2 Anode Header Cable

Cable for anode header and distribution shall be No. 2 AWG stranded copper wire with type CP high molecular weight polyethylene, 2.8 mm thick insulation, 600-volt rating, in accordance with NEMA WC 5.

###### 2.4.1.3 Test Wires

Test wires shall be AWG No. 12 stranded copper wire with NFPA 70 Type TW or RHW or polyethylene insulation.

###### 2.4.1.4 Resistance Wire

Resistance wire shall be AWG No. 16 or No. 22 nickel-chromium wire.

##### 2.4.2 Conduit

Rigid galvanized steel conduit and accessories shall conform to UL 6. Nonmetallic conduit shall conform to NEMA TC 2.

##### 2.4.3 Test Boxes and Junction Boxes

Boxes shall be outdoor type conforming to UL 514A.



#### 2.4.4 Polyethylene Insulation

Polyethylene insulation shall comply with the requirements of ASTM D 1248 and of the following types, classes, and grades:

##### 2.4.4.1 High Molecular Weight Polyethylene

High molecular weight polyethylene shall be Type I, Class C, Grade E5.

##### 2.4.4.2 High Density Polyethylene

High density polyethylene shall be Type III, Class C, Grade E3.

#### 2.4.5 Test Stations

Test stations shall be complete with an insulated terminal block having the indicated number of terminals and shall be provided with a lockable cover and have a cast-in legend, "C.P. Test". Test stations shall be complete with an insulated terminal block having the required number of terminals. (One terminal required for each conductor). Sufficient test stations to monitor underground isolation points shall be provided. Test-bond stations (potential measurement and stray current control) shall be provided to monitor pipe to soil potential of proposed underground pipes or existing underground metallic structures which may conduct stray current from the new cathodic protection system. The location of the test-bond stations shall ensure that the pipe to soil potential of metallic pipe not designated to be protected is not made less negative by the energization of the cathodic protection system. Test station terminal connections and the terminal conductor shall be permanently tagged to identify each termination of the conductors (e.g. identify the conductors connected to the protected structures). Conductors shall be permanently identified in the station by means of plastic or metal tags, or plastic sleeves to indicate termination. Each conductor shall be color coded in accordance with the drawings. The station test facility, including permanent Cu-Cu S04 reference cells and test returns shall be installed as indicated. Pavement inserts shall be nonmetallic and shall allow Cu-Cu S04 reference electrode to contact the electrolyte beneath the pavement surface. Abbreviations shall not be used. Welding of electrical connections shall be as follows: Exothermic welds shall be "CADweld", "Thermo-weld", or approved equal. Use and selection of these materials and welding equipment shall be in accordance with the manufacturer's recommendations.

#### 2.4.6 Calibrated Shunts

Shunts calibrated in current per potential (e.g. mA/V) shall be installed between the lead or header wire connected to the sacrificial anode and the current collector lead connected to the structure. The calibration of the shunt shall be clearly marked and installed to be visible.

#### 2.4.7 Sealing and Dielectric Compound

Sealing and dielectric compound shall be a black, rubber based compound that is soft, permanently pliable, tacky, moldable, and unbacked. Compound shall be applied as recommended by the manufacturer, but not less than 3.2 mm thick.

#### 2.4.8 Protective Covering

Except as otherwise specified, protective covering for underground metallic components including pipe and fittings shall be applied mechanically in a factory or field plant specially equipped for the purpose. Valves and fittings that cannot be coated and wrapped mechanically shall have the protective covering applied by hand, preferably at the plant applying the covering to the pipe. Joints shall be coated and wrapped by hand. Hand coating and wrapping shall produce a covering equal in thickness to the covering applied mechanically. Piping and components installed in valve boxes or manholes shall also receive the specified protective coating.

##### 2.4.8.1 Pipeline Metallic Components

Underground metallic pipelines and structures shall have a good quality factory applied coating. This includes carbon steel, cast iron and ductile iron pipelines or vessels. If nonmetallic pipelines are installed, metallic fittings or pipe sections are to be coated as follows.

- a. The nominal thickness of the metallic pipe joint or other component coating shall be 1.5 mm, plus or minus 5 percent.
- b. Pipe and joint coating for factory applied or field repair material shall be applied as recommended by the manufacturer and shall be one of the following:
  - (1) Continuously extruded polyethylene and adhesive coating system.
  - (2) Polyvinyl chloride pressure-sensitive adhesive tape.
  - (3) High density polyethylene/bituminous rubber compound tape.
  - (4) Butyl rubber tape.
  - (5) Coal tar epoxy.

##### 2.4.8.2 Field Joints

Field joints shall be coated with material compatible with the pipeline coating compound. The joint coating material shall be applied to an equal thickness as the pipeline coating. Unbonded coatings shall not be used on buried metallic piping. This prohibition includes unbonded polymer wraps or tubes.

##### 2.4.8.3 Inspection of Pipe Coatings

Once the pipeline or vessel is set in the trench, an inspection of the coating shall be conducted. This inspection shall include electrical holiday detection as described in paragraph TESTS AND MEASUREMENTS.

##### 2.4.8.4 Above Ground Piping System

Above ground piping shall be given two coats of exterior oil paint. Surface preparation shall be as recommended by paint manufacturer, except as follows: ferrous, shop primed surfaces shall be touched up with ferrous metal primer; surfaces that have not been shop primed shall be solvent cleaned; surfaces that contain loose rust, mil scale, or other foreign

substances shall be mechanically cleaned by power wire brushing and primed with ferrous metal primer; and primed surfaces shall be finished with two coats of exterior oil paint or vinyl paint.

#### 2.4.9 Preformed Sheaths

Preformed sheaths for encapsulating electrical wire splices to be buried underground shall fit the insulated wires entering the spliced joint.

#### 2.4.10 Epoxy Potting Compound

Epoxy potting compound for encapsulating electrical wire splices to be buried underground shall be a two package system made for the purpose.

#### 2.4.11 Backfill Shields

Backfill shields shall consist of approved pipeline wrapping or fiberglass reinforced, coal-tar impregnated tape, or plastic weld caps, specifically made for the purpose.

#### 2.4.12 Electrical Tape

Pressure-sensitive vinyl plastic electrical tape shall conform to UL 510.

#### 2.4.13 Cable Marker Tape

Traceable marker tape shall be manufactured for the purpose and clearly labeled "Cathodic Protection Cable Buried Below".

#### 2.4.14 Electrically Insulating Pipe Joints

Electrically insulating pipe joints for above or below ground use shall be flexible, mechanical pipe couplings of an electrically insulating type consisting of bolted or compression design provided with electrically insulating joint harness if required to provide pull-out strength flexible or factory assembled electrically insulating pipe joints designed with stub ends for installation by welding and providing pull-out strength with a factor of safety.

##### 2.4.14.1 Threaded Fittings

Threaded type electrically insulating pipe joints shall have molded plastic screw threads and be used above ground only. Machined plastic screw threads shall not be used.

##### 2.4.14.2 Electrically Insulating Pipe Joints

Electrically insulating pipe joints shall be of a type that is in regular factory production.

#### 2.4.15 Electrically Conductive Couplings

Electrically conductive couplings shall be of a type that has a published maximum electrical resistance rating given in the manufacturer's literature. Cradles and seals shall be of a type that is in regular factory production made for the purpose of electrically insulating the carrier pipe from the casing and preventing the incursion of water into the annular space.

#### 2.4.16 Joint and Continuity Bonds

Bonds shall be provided across joints or any electrically discontinuous connections in the piping, and other pipes and structures with other than welded or threaded joints included in this cathodic protection system. Unless otherwise specified, bonds between structures and across joints in pipe with other than welded or threaded joints shall be with No. 4 AWG stranded copper cable with polyethylene insulation. Bonds between structures shall contain sufficient slack for any anticipated movement between structures. Bonds across pipe joints shall contain a minimum of 100 mm of slack to allow for pipe movement and soil stress. Bonds shall be attached by exothermic welding. Exothermic weld areas shall be insulated with coating compound and approved by the Contracting Officer. Continuity bonds shall be installed as necessary to reduce stray current interference. Additional joint bonding shall be done where determined during construction or testing or as directed by the Contracting Officer. Joint bonding shall include excavation and backfilling. There shall be a minimum of 2 continuity bonds between each structure and other than welded or threaded joints. Electrical continuity shall be tested across joints with other than welded or threaded joints and across metallic portions of sewage lift stations and water booster stations.

##### 2.4.16.1 Resistance Bonds

Resistance bonds shall be adjusted for minimum interference while achieving the criteria of protection. Alternate methods may be used when approved.

##### 2.4.16.2 Stray Current Measurements

Stray current measurements shall be performed as indicated. Alternate methods may be used when approved. The stray current test report shall indicate location of test, type of pipes tested, method of testing.

#### 2.4.17 Electrical Isolation of Structures

Insulating fittings, including insulating flanges and couplings, shall be installed above ground or in a concrete hand hole. As a minimum, insulating flanges or unions shall be provided at the following locations:

- a. Connection of new piping to existing pipes.
- b. Pressure piping under floor slab to a building.

Additionally, isolation shall be provided between new pipe lines and foreign pipes that cross the new lines within 3 meters.

## 2.5 MAGNESIUM ANODES

Weights and dimensions of magnesium anodes shall be approximately as follows:

TYPICAL MAGNESIUM ANODE SIZES  
(Cross sections may be round, square, or D shaped)

NOMINAL WT. kg.	APPROX. SIZE (mm)	NOMINAL GROSS WT kg PACKAGED IN BACKFILL	NOMINAL PACKAGE DIMENSIONS (mm)
1.4	76 X 76 X 127	3.6	133 X 133 X 203
2.3	76 X 76 X 203	5.9	133 X 133 X 286
4.1	76 X 76 X 356	12.3	133 X 508
5.5	102 X 102 X 305	14.5	191 X 457
7.7	102 X 102 X 432	20.5	191 X 610
14.5	127 X 127 X 521	30.9	216 X 711
22.7	178 X 178 X 406	45.5	254 X 610

## 2.5.1 Composition

Anode shall be of high potential magnesium alloy, made of primary magnesium obtained from sea water or brine, and not from scrap metal. Anodes shall conform to the following analysis, unless otherwise indicated.

Element	Percent by Weight
Aluminum	0.02 maximum
Manganese	1.50 maximum
Zinc	0.05
Silicon	0.10 maximum
Copper	0.02 maximum
Nickel	0.002 maximum
Iron	0.03 maximum
Impurities	0.30 maximum
Magnesium	Remainder

The Contractor shall furnish spectrographic analyses on samples from each heat or batch of anodes used on this project.

## 2.5.2 Packaged Anodes

Anodes shall be provided in packaged form with the anode surrounded by specially prepared quick-wetting backfill and contained in a cloth or paper sack. Anodes shall be centered in the backfill material. The backfill material shall have the following composition, unless otherwise indicated.

Material	Percent by Weight
Gypsum	75
Bentonite	20
Sodium Sulfate	5

### 2.5.3 Lead Wires

Anode lead wires shall consist of No. 10 solid copper wire, with TW insulation. Lead wires shall be not less than 3 meters in length, without splices.

### 2.5.4 Connection Wires

Wires shall consist of No. 10 solid copper wire with RHW-USE or polyethylene insulation.

### 2.5.5 Insulation

Type RHW-USE insulation shall comply with NFPA 70. Polyethylene insulation shall comply with ASTM D 1248; high molecular weight polyethylene shall be Type I, Class C, Grade E5; high density polyethylene shall be Type III, Class C, Grade E3.

### 2.5.6 Conduit Steel

Conduit steel shall conform to UL 6 and ANSI C80.1.

### 2.5.7 Tape

Pressure-sensitive vinyl plastic electrical tape shall conform to UL 510.

### 2.5.8 Backfill Shields

Shields shall consist of approved wrapping of reinforced fiberglass coal-tar impregnated tape, or plastic weld caps specifically made for the purpose and installed in accordance with the manufacturer's recommendations. When joint bonds are required, due to the use of mechanical joints, the entire joint shall be protected with kraft paper joint cover. The joint cover shall be filled with poured hot coal-tar enamel.

### 2.5.9 Electrical Connections

Electrical connections shall be done as follows:

- a. Exothermic welds shall be "Cadweld" or Burndy "Thermo-Weld" or approved equal. Use of these materials shall be in accordance with the manufacturer's recommendations.
- b. Electrical shielded arc welds on steel pipe shall be approved via shop drawing action.
- c. Other methods of welding shall be specifically approved for use by the pipe manufacturer.

### 2.5.10 Anode Storage

Storage for magnesium anodes will be designated by the Contracting Officer. If anodes are not stored in a building, they shall be protected from inclement weather. Packaged anodes damaged as result of improper handling or weather exposure shall be resacked by the Contractor and the required backfill added.

### 2.5.11 Anode Installation

Anode configuration and size shall be as required. The contractor shall provide as many anodes as required by the design to achieve minus 850 millivolts "instant off" potential and shall be required on the components or structure. Details shown are indicative of the general type of material required and are not intended to restrict selection of materials or of any particular manufacturer. The anode system shall be designed for a life of 25 years of continuous operation.

### 2.6 LEAD WIRE CONNECTIONS

Lead wire to structure connections shall be by exothermic welding process. Weld charges made specifically for use on cast iron shall be used on cast iron pipe. A backfill shield filled with a pipeline mastic sealant or material compatible with the coating shall be placed over the weld connection and shall cover the exposed metal adequately.

## 3 EXECUTION

### 3.1 CRITERIA OF PROTECTION

Acceptance criteria for determining the adequacy of protection on a buried pipe shall be in accordance with NACE RP0169 and as specified below.

#### 3.1.1 Iron and Steel

The following method a. shall be used for testing cathodic protection voltages. If more than one method is required method b. shall be used:

- a. A negative voltage of at least minus 0.85 volts as measured between the pipe and a saturated copper-copper sulphate reference electrode contacting the (electrolyte) earth directly over the pipe. Determination of this voltage shall be made with the cathodic protection system in operation. Voltage drops shall be considered for valid interpretation of this voltage measurement. A minimum of minus 850 millivolts "instant off" potential between the pipe being tested and the reference cell shall be achieved over 95 percent of the area of the structure. Adequate number of measurements shall be obtained over the entire structure, pipe, tank, or other metallic component to verify and record achievement of minus 850 millivolts "instant off". This potential shall be obtained over 95 percent of the total metallic area without the "instant off" potential exceeding 1200 millivolts.
- b. A minimum polarization voltage shift of 100 millivolts as measured between the pipe and a saturated copper-copper sulphate reference electrode contacting the earth directly over the pipe. This polarization voltage shift shall be determined by interrupting the protective current and measuring the polarization decay. When the protective current is interrupted, an immediate voltage shift will occur. The voltage reading, after the immediate shift, shall be used as the base reading from which to measure polarization decay. Measurements achieving 100 millivolts shall be made over 95 percent of the metallic surface.

### 3.1.2 Aluminum

Aluminum pipes shall not be protected to a potential more negative than minus 1.20 volts, measured between the pipe and a saturated copper-copper sulphate reference electrode contacting the earth, directly over the pipe. Resistance, if required, shall be inserted in the anode circuit within the test station to reduce the potential of the aluminum pipe to a value which will not exceed a potential more negative than minus 1.20 volts. Voltage shift criterion shall be a minimum negative polarization shift of 100 millivolts measured between the pipe and a saturated copper-copper sulphate reference electrode contacting the earth, directly over the pipe. The polarization voltage shift shall be determined as outlined for iron and steel.

### 3.1.3 Copper Piping

For copper piping the following criteria shall apply. A minimum of 100 millivolts of cathodic polarization between the structure surface and a stable reference electrode contacting the electrolyte. The polarization voltage shift shall be determined as outlined for iron and steel.

## 3.2 GROUND BED INSTALLATION

### 3.2.1 Shallow Ground Beds

Shallow ground beds shall contain size and quantity of anodes designed to meet performance criteria of the cathodic protection system at an initial operating current output density not exceeding 50 percent of maximum recommended current output density.

#### 3.2.1.1 Horizontally Buried Bare Anodes

Horizontally buried bare anodes shall be bedded on and covered with metallurgical coke breeze in a trench excavated for the purpose at depths, spacing and locations as shown. Anodes shall be completely surrounded by the backfill at bottom, sides, and top for a distance of not less than 100 mm. Backfill shall be compacted.

#### 3.2.1.2 Vertically Buried Bare Anodes

Vertically buried bare anodes shall be installed in vertical holes in the ground having a depth, spacing, and location shown. The holes in the ground shall be sufficiently large to provide an annular space around the anode not less than 100 mm. The anodes shall be centered in the hole and backfilled with calcined petroleum coke breeze or metallurgical coke breeze. Backfill shall be compacted.

#### 3.2.1.3 Horizontally Buried Canister-Contained Anodes

Horizontally buried canister-contained anodes shall be buried in a trench excavated for the purpose at depths, spacing, and locations shown.

#### 3.2.1.4 Vertically Buried Canister-Contained Anodes

Vertically buried canister-contained anodes shall be installed in vertical holes in the ground having depth, spacing, and locations shown. The holes in the ground shall be sufficiently larger in diameter than the canisters to



facilitate easy lowering into the hole and backfilling. The space between the canister and the wall of the hole shall be completely backfilled with a wet slurry of earth free of stones.

#### 3.2.1.5 Cable Protection

Positive cable to the ground bed and negative cable to the pipe to be protected shall be buried a minimum depth of 750 mm except where above ground construction utilizing conduit is used.

#### 3.2.1.6 Multiple Anode Systems

Multiple anode systems shall consist of groups of anodes connected in parallel to a header cable, buried in the ground at depths, spacing, and locations shown. The anodes shall be buried vertically.

#### 3.2.1.7 Distributed Anode Systems

Distributed anode systems shall consist of a line or row of anodes connected in parallel to a header cable and buried in the ground parallel to the pipeline. The anodes shall be at the pipeline at depths, spacing, and locations shown. The anodes shall be buried vertically.

#### 3.2.2 Deep Anode Ground Beds

Deep anode ground beds shall consist of an installation of anodes supported in a well spaced one above the other and supported in place by a method that does not suspend the anodes from the connecting cable.

##### 3.2.2.1 Anode Centering

Anodes shall be centered in the well by means of centering devices.

##### 3.2.2.2 Well Casing

The well casing shall be bare steel to a depth and elevation of not more than 1.5 meters.

##### 3.2.2.3 Casing Insulation

The portion of casing above the top anode shall be coated with an electrically insulating underground type coating.

##### 3.2.2.4 Anode Requirements

Anode sizes, spacing, number of anodes, depth of well, and other details shall be as shown.

##### 3.2.2.5 Anode Lead Wire

Each anode shall have a separate, continuous wire extending from the anode in the well to the junction box at the well head.

#### 3.2.2.6 Anode Cables

Anode cables shall terminate in a nearby junction box, equipped with individual anode current shunts. Where full length casing is used, two wire connections from casing shall terminate in the junction box.

#### 3.2.2.7 Anode and Cable Installation

If the method of installation utilizes backfill support for anodes and cable, slack in the cable near each anode shall be provided and the cable insulation shall be increased in thickness from 2.8 mm to 4.0 mm utilizing an approved composite of plastic and elastomeric materials.

#### 3.2.2.8 Backfill

The well shall be backfilled with calcined petroleum coke breeze or metallurgical coke breeze surrounding the anodes by a method that does not leave voids or bridging. The well shall be over-filled with coke breeze allowing for settlement so that the settled level after a number of days is as high as the level shown. The number of days allowed for settling of the coke breeze will be determined by the Contracting Officer. If the top level of coke breeze is below the level shown after settlement, additional coke breeze shall be put in the well. Anode and cable assemblies shall not be used for tamping backfill around another, previously placed anode unless recommended in writing by the manufacturer of the anode and cable assembly. The top portion of the well above the level of the coke breeze shall be filled with washed gravel. The top of the well shall be vented to the atmosphere.

#### 3.2.2.9 Cable Marker Tape

Traceable marker tape shall be located in the same trench above cathodic protection cables including structure leads, anode leads, anode header cables, test station leads, bonding cables, and rectifier electrical power cables.

#### 3.2.2.10 Pavement Inserts

Pavement inserts shall be installed at a minimum of 30 meter intervals for pipelines. The pavement inserts shall be installed directly over the structure being protected and tested.

### 3.3 MAGNESIUM ANODE INSTALLATION

Installation shall not proceed without the presence of the Contracting Officer, unless otherwise authorized. Anode locations may be changed to clear obstructions when approved. Anodes shall be installed in sufficient number and of the required type, size, and spacing to obtain a uniform current distribution surface on the structure. Prepackaged anodes shall be installed as shown on the drawings.

#### 3.3.1 General Requirements

Packaged anodes shall be installed completely dry, and shall be lowered into holes by rope sling or by grasping the cloth gather. The anode lead wire shall not be used in lowering the anodes. The hole shall be backfilled with fine soil in 150 mm layers and each layer shall be hand-tamped around the

anode. The tamper shall not strike the anode or lead wire. If immediate testing is to be performed, water shall be added only after backfilling and tamping has been completed to a point 150 mm above the anode. Approximately 8 liters of water shall be poured into the hole; after the water is absorbed by the soil, backfilling and tamping shall be completed to the top of the hole. Anodes shall be installed as shown. When rock is found prior to achieving specified depth, anode may be installed horizontally to a depth at least as deep as the bottom of the pipe, with the approval of the Contracting Officer.

### 3.3.2 Underground Metal Pipe Line

Anodes shall be installed 610 mm below the line to be protected unless otherwise noted on the drawings. To facilitate periodic electrical measurements during the life of the sacrificial anode system and to reduce the output current of the anodes if required, anode lead wires in a single group of anodes shall be buried a minimum of 610 mm and each anode lead wire shall be connected to an individual terminal in a test station. The anode lead cable shall make contact with the structure only through a test station. Resistance wire shall be installed between the anode lead cable and the pipe cable in the test station to reduce the current output, if required.

### 3.3.3 Lead and Resistance Wire Splices

Lead wire splicing, when necessary, shall be made with copper split bolt connectors of proper size. The joint shall be carefully wrapped with at least 3 layers of electrical tape. Resistance wire connections shall be done with silver solder and the solder joints wrapped with a minimum of 3 layers of pressure-sensitive tape.

### 3.3.4 Magnesium Anodes for Metallic Components

As a minimum, each metallic component shall be protected with 4 kg magnesium anodes located on each side of the metallic component and routed through a test station. Fire hydrant pipe component shall have a minimum of 4 kg magnesium anodes routed through a test station for each hydrant. Pipe under concrete slab shall have a minimum of 7.6 kg anodes for each location where metal pipe enters the building under the slab. A permanent reference cell shall be provided adjacent to the pipe entrance to the slab. Conductors shall be routed to a test station. Each valve shall have a minimum of 4 kg magnesium anodes routed through a test station. Sections of metallic pipe 6.1 meters long, when used where force mains are within 3 meters of the water pipe, shall have a minimum of 7.6 kg anodes.

## 3.4 MISCELLANEOUS INSTALLATION

### 3.4.1 Rectifier Installation

Mounting shall be Pole or wall mounting shall be equipped with a channel bracket, lifting eyes, and a keyhole at the top. Cross-arm brackets shall accommodate a 102 by 102 mm cross-arm.

### 3.4.2 Wire Connections

#### 3.4.2.1 Wire Splicing

Connecting wire splicing shall be made with copper compression connectors or exothermic welds, following instructions of the manufacturer. Split-bolt type connectors shall not be used.

#### 3.4.2.2 Steel Surfaces

Connections to ferrous pipe shall be made by exothermic weld methods as manufactured by an approved manufacturer for the type of pipe. Electric arc welded connections and other types of welded connections to ferrous pipe and structures shall be approved before use.

### 3.4.3 Pipe Joints

#### 3.4.3.1 Electrical Continuity

Underground pipe shall be electrically continuous except at places where electrically insulating joints are specified. Pipe joined by means other than welding shall meet the following electrical continuity requirements:

- a. Mechanical joints that are not factory designed to provide electrical continuity shall be bonded by installing a metallic bond across the joint. The bonding connections shall be made by the exothermic welding process.
- b. Mechanical joints designed to provide electrical continuity may be used.

#### 3.4.3.2 Coating

Mechanical joints and fittings of either the electrically conductive or insulating type shall be coated with an underground type dielectric coating system. Where external electrical continuity bonds are installed across mechanical joints, bare or exposed metal, welds, bare wire and exposed coupling parts shall be coated with a coating system.

- a. Couplings and fittings which have a low profile exterior designed to permit tape coating shall be primed and wrapped with an underground type pipe tape following recommendations of the coupling or fitting manufacturer.
- b. Couplings and fittings that cannot be properly taped shall be enclosed in a spaced mold manufactured for the purpose and filled with hot applied bituminous compound not exceeding 135 degrees C in application temperature.

### 3.4.3.3 Electrical Isolation of Structures

Electrical isolation of structures shall be as follows:

- a. Insulating Fittings: Insulating flanges and couplings shall be installed aboveground, or within manholes, wherever possible, but an insulating device that electrically separates a pipeline shall not be installed in a confined area where a combustible atmosphere may collect unless precautions are taken to prevent arcing such as by means of externally located surge arresters, grounding cells, or other means. Insulating flanges and couplings in lines entering buildings shall be located at least 300 mm above grade or floor level. Pipelines entering buildings either below or above ground shall be electrically isolated from the structure wall with an electrically isolating gas tight wall sleeve.
- b. Gas Distribution Piping: Electrical isolation shall be provided at each building riser pipe to the pressure regulator, at all points where a short circuit to another structure or to a foreign structure may occur, and at other locations as indicated.
- c. Steam, High Temperature, and Chilled Water, Line Supply and Return Piping, Line Conduit: Electrical isolation shall be provided at each building entrance, and at other locations as indicated.
- d. Gasline, Fire Suppression: Electrical isolation shall be provided in each pipe at the building.
- e. Copper Piping: Copper piping shall be wrapped with pipeline tape and electrically isolated at both ends.

Buried piping of dissimilar metals including new and old steel piping, excepting valves, shall be electrically separated by means of electrically insulating joints at every place of connection. The insulating joint, including the pipes, shall be coated with an underground type dielectric coating for a minimum distance of 10 diameters on each side of the joint.

### 3.4.4 Ferrous Valves

Dissimilar ferrous valves in a buried ferrous pipeline, including the pipe, shall be coated with an underground type dielectric coating for a minimum distance of 10 diameters on each side of the valve.

### 3.4.5 Brass or Bronze Valves

Brass or bronze valves shall not be used in a buried ferrous pipeline.

### 3.4.6 Metal Pipe Junction

If the dissimilar metal pipe junction, including valves, is not buried and is exposed to atmosphere only, the connection or valve, including the pipe, shall be coated with an underground type dielectric coating for a minimum distance of 3 diameters on each side of the junction.

#### 3.4.7 Casing

Where a pipeline is installed in a casing under a roadway or railway, the pipeline shall be electrically insulated from the casing, and the annular space sealed against incursion of water.

#### 3.4.8 Test Stations

Test stations shall be of the type and location shown and shall be curb box or post mounted. Buried electrically insulating joints shall be provided with test wire connections brought to a test station. Changes in designated location shall have prior approval. Unless otherwise shown, other test stations shall be located as follows:

- a. At 300 m intervals or less.
- b. Where the pipe or conduit crosses any other metal pipe.
- c. At both ends of casings under roadways and railways.
- d. Where both ends of an insulating joint are not accessible above ground for testing purposes.

### 3.5 TESTS AND MEASUREMENTS

#### 3.5.1 Baseline Potentials

Each test and measurement will be witnessed by the Contracting Officer. The Contractor shall notify the Contracting Officer a minimum of 5 working days prior to each test. After backfill of the pipe and anodes is completed, but before the anodes are connected to the pipe, the static potential-to-soil of the pipe shall be measured. The locations of these measurements shall be identical to the locations specified for pipe-to-reference electrode potential measurements.

#### 3.5.2 Insulation Testing

Before the anode system is connected to the pipe, an insulation test shall be made at each insulating joint or fitting. This test shall demonstrate that no metallic contact, or short circuit exists between the two insulated sections of the pipe. Any insulating fittings installed and found to be defective shall be reported to the Contracting Officer.

##### 3.5.2.1 Insulation Checker

A Model 601 insulation checker or an approved equal shall be used for insulating joint (flange) electrical testing. Manufacturer's operating instructions shall be adhered to. An insulating joint that is good will read full scale on the meter. If an insulating joint is shorted, the meter pointer will be deflected or near zero on the meter scale. Location of the fault shall be determined from the instructions and the joint shall be repaired. If an insulating joint is located inside a vault, the pipe shall be sleeved with insulator when entering and leaving the vault.

### 3.5.2.2 Cathodic Protection Meter

A Model B3A2 cathodic protection meter or an approved equal using the continuity check circuit shall be used for insulating joint (flange) electrical testing. This test shall be performed in addition to the Model 601 insulation checker. Continuity is checked across the insulated joint after the test lead wire is shorted together and the meter adjusted to scale. A full scale deflection indicates the system is shorted at some location. The Model 601 verifies that the particular insulation under test is good and the Model B3A2 verifies that the system is isolated. If the system is shorted, further testing shall be performed to isolate the location of the short.

### 3.5.3 Anode Output

As the anodes or groups of anodes are connected to the pipe, current output shall be measured with an approved low resistance ammeter. The values obtained and the date, time, and locations shall be recorded.

### 3.5.4 Electrode Potential Measurements

Upon completion of the installation and with the entire cathodic protection system in operation, electrode potential measurements shall be made using a copper-copper sulphate reference electrode and a potentiometer-voltmeter, or a direct current voltmeter having an internal resistance (sensitivity) of not less than 10 megohms per volt and a full scale of 10 volts. The locations of these measurements shall be identical to the locations used for baseline potentials. The values obtained and the date, time, and locations of measurements shall be recorded. No less than 8 measurements shall be made over any length of line or component. Additional measurements shall be made at each distribution service riser, with the reference electrode placed directly over the service line.

### 3.5.5 Location of Measurements

#### 3.5.5.1 Coated Piping or Conduit

For coated piping or conduit, measurements shall be taken from the reference electrode located in contact with the earth, directly over the pipe. Connection to the pipe shall be made at service risers, valves, test leads, or by other means suitable for test purposes. Pipe to soil potential measurements shall be made at intervals not exceeding 1.5 meters. The Contractor may use a continuous pipe to soil potential profile in lieu of 0.75 m interval pipe to soil potential measurements. Additional measurements shall be made at each distribution service riser, with the reference electrode placed directly over the service line adjacent to the riser. Potentials shall be plotted versus distance to an approved scale. Locations where potentials do not meet or exceed the criteria shall be identified and reported to the Contracting Officer.

### 3.5.6 Casing Tests

Before final acceptance of the installation, the electrical separation of carrier pipe from casings shall be tested and any short circuits corrected.

### 3.5.7 Interference Testing

Before final acceptance of the installation, interference tests shall be made with respect to any foreign pipes in cooperation with the owner of the foreign pipes. A full report of the tests giving all details shall be made.

### 3.5.8 Holiday Test

Any damage to the protective covering during transit and handling shall be repaired before installation. After field coating and wrapping has been applied, the entire pipe shall be inspected by an electric holiday detector with impressed current in accordance with NACE RP0188 using a full ring, spring type coil electrode. The holiday detector shall be equipped with a bell, buzzer, or other type of audible signal which sounds when a holiday is detected. Holidays in the protective covering shall be repaired upon detection. Occasional checks of holiday detector potential will be made by the Contracting Officer to determine suitability of the detector. Labor, materials, and equipment necessary for conducting the inspection shall be furnished by the Contractor. The coating system shall be inspected for holes, voids, cracks, and other damage during installation.

### 3.5.9 Recording Measurements

All pipe-to-soil potential measurements including initial potentials where required shall be recorded. The Contractor shall locate, correct and report to Contracting Officer any short circuits to foreign pipes encountered during checkout of the installed cathodic protection system. Pipe-to-soil potential measurements are required on as many pipes as necessary to determine the extent of protection or to locate short-circuits.

## 3.6 TRAINING COURSE

The Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total of 16 hours of normal working time and shall start after the system is functionally completed but prior to final acceptance tests. The field instructions shall cover all of the items contained in the operating and maintenance instructions, as well as demonstrations of routine maintenance operations, including testing procedures included in the maintenance instructions. At least 14 days prior to date of proposed conduction of the training course, the training course curriculum shall be submitted for approval, along with the proposed training date. Training shall consist of demonstration of test equipment, providing forms for test data and the tolerances which indicate that the system works satisfactorily.



## SECTION 16721

## FIRE DETECTION AND ALARM SYSTEM

## 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41 (1991) Surge Voltages in Low-Voltage AC Power Circuits

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (1993) National Electrical Code

NFPA 72 (1993) National Fire Alarm Code

NFPA 90A (1993) Installation of Air Conditioning and Ventilating Systems

## UNDERWRITERS LABORATORIES (UL)

UL-04 (1994) Fire Protection Equipment Directory

UL 6 (1993) Rigid Metal Conduit

UL 38 (1994; Rev Jan 1994) Manually Actuated Signaling Boxes for Use with Fire-Protective Signaling Systems

UL 268 (1989; Rev May 1989) Smoke Detectors for Fire Protective Signaling Systems

UL 464 (1990) Audible Signal Appliances

UL 467 (1993) Grounding and Bonding Equipment

UL 521 (1993) Heat Detectors for Fire Protective Signaling Systems

UL 797 (1993) Electrical Metallic Tubing

UL 864 (1991; Rev thru May 1994) Control Units for Fire-Protective Signaling Systems

UL 1242 (1983; Rev thru Jul 1993) Intermediate Metal Conduit

## 1.2 GENERAL REQUIREMENTS

### 1.2.1 Standard Products

Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall be items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that can provide service within 24 hours.

### 1.2.2 Nameplates

Major components of equipment shall have the manufacturer's name, address, type or style, voltage and current rating, and catalog number on a noncorrosive and nonheat-sensitive plate which is securely attached to the equipment.

### 1.2.3 Keys and Locks

Locks shall be keyed alike.

### 1.2.4 Tags

Tags with stamped identification number shall be furnished for keys and locks.

### 1.2.5 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

### 1.2.6 Compliance

The fire detection and internal alarm system and the central reporting system shall be configured in accordance with NFPA 72. The equipment furnished shall be compatible and be UL listed or FM approved or approved or listed by a nationally recognized testing laboratory in accordance with the applicable NFPA standards.

### 1.2.7 Manufacturer's Services

Services of a manufacturer's representative who is experienced in the installation, adjustment, testing, and operation of the equipment specified shall be provided. The representative shall supervise the installation, adjustment, and testing of the equipment.

## 1.3 SYSTEM DESIGN

### 1.3.1 Operation

The fire alarm and detection system shall be a complete, supervised fire alarm system. The system shall be activated into the alarm mode by actuation of any alarm initiating device. The system shall remain in the alarm mode until initiating device is reset and the fire alarm control panel is reset and restored to normal. Alarm initiating devices shall be connected to initiating device circuits (IDC), Style D, or to signal line

circuits (SLC), Style 6, in accordance with NFPA 72. Alarm indicating appliances shall be connected to indicating appliance circuits (IAC), Style Z in accordance with NFPA 72. A two-loop conduit system shall be provided so that if any one conduit and all conductors contained in that conduit are severed all IDC, IAC, or SLC on that circuit shall remain functional. A two-loop system is not applicable to the central fire alarm communication center from the local panels. All textual, audible, and visual appliances and systems shall comply with NFPA 72 and NFPA 72G.

Sleeping room smoke detectors with self contained audible local alarms are for local alarm, but must report a trouble signal to the Fire Alarm Control Panel if a detector head is removed from its base.

Addressable system shall be microcomputer (microprocessor or microcontroller) based with a minimum word size of eight bits.

- a. Sufficient memory shall be provided to perform as specified and as shown for addressable system.

- b. Individual identity of each addressable device shall be provided for the following conditions:

- alarm
  - trouble
  - open
  - short
  - appliances missing/failed

- c. All addressable devices shall have the capability of individually being disabled or enabled from the panel.

#### 1.3.2 Operational Features

The system shall have the following operating features:

- a. Electrical supervision of alarm IDC SLC and IAC.
- b. Electrical supervision of the primary power (ac) supply, battery voltage, placement of alarm zone module (card, PC board) within the control panel, and transmitter tripping circuit integrity.
- c. Trouble buzzer and trouble lamp (light emitting diode or neon light) to activate upon a single break, open, or ground fault condition which prevents the required normal operation of the system. The trouble signal shall also operate upon loss of primary power (ac) supply, low battery voltage, removal of alarm zone module (card, PC board), and disconnection of the circuit used for transmitting alarm signals off-premises. A trouble alarm silence switch shall be provided which will silence the trouble buzzer, but will not extinguish the trouble indicator lamp. After the system returns to normal operating conditions, the trouble buzzer shall again sound until the silencing switch returns to normal position, unless automatic trouble reset is provided.
- d. Transmitter disconnect switch to allow testing and maintenance of the system without activating the transmitter but shall provide a

trouble signal when disconnected and a restoration signal when reconnected.

- e. Evacuation alarm silencing switch or switches which, when activated, will silence alarm devices, but will not affect the zone indicating lamp nor the operation of the transmitter. This switch shall be over-ridden upon activation of a subsequent alarm from an unalarmed zone and the alarm devices will be activated.
- f. Electrical supervision of circuits used for supervisory signal services. Supervision shall detect any open, short, or ground.
- g. Confirmation or verification modules used on smoke detection initiating circuits. The modules shall interrupt the transmission of an alarm signal to the system control panel for a factory set period. This interruption period shall be adjustable from 1 to 60 seconds and be factory set at 20 seconds. Immediately following the interruption period, a confirmation period shall be in effect during which time an alarm signal if present will be sent immediately to the control panel. All fire alarm devices other than smoke detectors shall be prohibited on circuits controlled by confirmation or verification modules.

#### 1.3.3 Alarm Functions

An alarm condition on a circuit shall automatically initiate the following functions:

- a. Transmission of a signal over the station telephonic fire reporting system. The signal shall be common for all signal loops.
- b. Visual indications of the alarmed devices on the fire alarm control panel annunciator and on the remote annunciator.
- c. Continuous sounding of alarm notification appliances throughout the building.
- d. Deactivation of the air handling units throughout the building.

#### 1.3.4 Primary Power

Operating power shall be provided as required by paragraph Power Supply for the System. Transfer from normal to emergency power or restoration from emergency to normal power shall be fully automatic and not cause transmission of a false alarm. Loss of ac power shall not prevent transmission of a signal via the fire reporting system upon operation of any initiating circuit.

#### 1.3.5 Battery Backup Power

Battery backup power shall be through use of rechargeable, sealed-type storage batteries and battery charger.

#### 1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FI0" designation are for information only. The

following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

SD-01 Data

Battery; GA.

Substantiating battery calculations for supervisory and alarm power requirements. Ampere-hour requirements for each system component and each panel component, and the battery recharging period shall be included.

Voltage Drop; GA.

Voltage drop calculations for signaling appliance circuits to indicate that sufficient voltage is available for proper appliance operation.

Spare Parts; FIO.

Spare parts data for each different item of material and equipment specified, not later than 1 month prior to the date of beneficial occupancy. Data shall include a complete list of parts and supplies with the current unit prices and source of supply and a list of the parts recommended by the manufacturer to be replaced after 1 year of service.

Qualifications; GA.

Qualifications, with verification of experience and license number, of a Registered Professional Engineer with at least 4 years of current experience in the design of the fire protection and detection systems. This engineer must perform the various specification items required by this section to be performed by a registered Professional Engineer.

SD-04 Drawings

Fire Alarm Reporting System; GA.

Detail drawings, signed by the Registered Professional Engineer, consisting of a complete list of equipment and material, including manufacturer's descriptive and technical literature, catalog cuts, and installation instructions. Note that the contract drawings show layouts based on typical detectors. The contractor shall check the layout based on the actual detectors to be installed and make any necessary revisions in the detail drawings. The detail drawings shall also contain complete wiring and schematic diagrams for the equipment furnished, equipment layout, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit.

Detailed point-to-point wiring diagram, signed by the Registered Professional Engineer, showing all points of connection. Diagram shall include connections between system devices, appliances, control panels, supervised devices, and all equipment that is activated or controlled by the panel.

SD-06 Instructions

Fire Alarm Reporting System; GA.

Six copies of operating instructions outlining step-by-step procedures required for system startup, operation, and shutdown. The instructions shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Six copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The instructions shall include conduit layout, equipment layout and simplified wiring, and control diagrams of the system as installed. Instructions shall be approved prior to training.

Training; FIO.

Lesson plans and training data, in manual format, for the training courses.

#### SD-08 Statements

Test Procedures; FIO.

Detailed test procedures, signed by the Registered Professional Engineer, for the fire detection and alarm system 60 days prior to performing system tests.

#### SD-09 Reports

Testing; GA.

Test reports in booklet form showing all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall document all readings, test results and indicate the final position of controls.

#### SD-13 Certificates

Equipment; FIO.

Certified copies of current approvals or listings issued by UL, FM or other nationally recognized testing laboratory, showing compliance with specified NFPA standards.

Installer; GA.

The Contractor shall provide documentation demonstrating that its fire detection and alarm system installer has been regularly engaged in the installation of fire detection and alarm systems meeting NFPA standards for a minimum of three years immediately preceding commencement of this contract. Such documentation shall specifically include proof of satisfactory performance on at least three projects similar to that required by these specifications, including the names and telephone numbers of using agency points of contact for each of these projects. Documentation shall indicate the type of each system installed and include a written certificate that each system has performed satisfactorily in the manner specified for a period of not less than 12 months following completion. All such data shall be submitted 30 days prior to commencement of installation for approval of the Contracting Officer. Listing of the installer under "Protective Signaling Services - Local, Auxiliary, Remote Station Proprietary (UUJS)" of UL-04 shall be accepted as equivalent proof of compliance with the foregoing experience requirements.

## 1.5 DELIVERY AND STORAGE

All equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variation, dirt and dust, and any other contaminants.

## 2 PRODUCTS

### 2.1 CONTROL PANEL

Control Panel shall comply with all the applicable requirements of UL 864. Panel shall be modular, installed in a surface mounted steel cabinet with hinged door and cylinder lock. Control panel shall be a clean, uncluttered, and orderly assembled panel containing all components and equipment required to provide the specified operating and supervisory functions of the system. The panel shall have prominent rigid plastic, phenolic or metal identification plates for all lamps, zones, controls, meters, fuses, and switches. Nameplates for fuses shall also include ampere rating. Separate alarm and trouble lamp shall be provided for each zone alarm located on exterior of cabinet door or be visible through the cabinet door. Control panel switches shall be within the locked cabinet. A suitable means shall be provided for testing the control panel visual indicating devices (meters or lamps). Meters and lamps shall be plainly visible when the cabinet door is closed. Signals shall be provided to indicate by zone any alarm, supervisory or trouble condition on the system. Each SLC initiating circuit shall be powered and supervised so that a signal on one zone does not prevent the receipt of signals from other zones. Loss of power, including any or all batteries, shall not require the reloading of a program. Upon restoration of power, startup shall be automatic, and shall not require any manual operation. The loss of primary power or the sequence of applying primary or emergency power shall not affect the transmission of alarm, supervisory or trouble signals.

#### 2.1.1 Visual Annunciators

Visual annunciators shall be provided for each active addressable device on the CPU alphanumeric annunciator. Device identification shall consist of type of device and its location: ie., heat detector, room 325, attic.

#### 2.1.2 Cabinets

Cabinets shall be provided with ample gutter space to allow proper clearance between the cabinet and live parts of the panel equipment. If more than one modular unit is required to form a control panel, the units shall be installed in a single cabinet large enough to accommodate all units. Cabinets shall be painted red.

#### 2.1.3 Circuit Connections

Circuit conductors entering or leaving the panel shall be connected to screw-type terminals with each terminal marked for identification.

### 2.2 STORAGE BATTERIES

Storage Batteries shall be provided and shall be the sealed, lead-calcium type requiring no additional water. The batteries shall have ample

capacity, with primary power disconnected, to operate the fire alarm system for a period of 48 hours. Following this period of operation via batteries, the batteries shall have ample capacity to operate all components of the system, including all alarm signaling devices in the total alarm mode for a minimum period of 15 minutes. Batteries shall be sized to deliver 50 percent more ampere/hours based on a 48 hour discharged rate than required for the calculated capacities. Battery cabinet shall be a separate compartment within the control panel. Batteries in the control panel shall be located at the bottom of the panel. Battery shall be provided with overcurrent protection in accordance with NFPA 72.

### 2.3 BATTERY CHARGER

Battery charger shall be completely automatic, with high/low charging rate, capable of restoring the batteries from full discharge to full charge within 12 hours. A separate ammeter shall be provided for indicating rate of charge. A separate voltmeter shall be provided to indicate the state of the battery charge. A pilot light indicating when batteries are manually placed on a high rate of charge shall be provided as part of the unit assembly if a high rate switch is provided. Charger shall be located in control panel or battery cabinet.

### 2.4 MANUAL FIRE ALARM STATIONS

Manual fire alarm stations shall conform to the applicable requirements of UL 38. Manual stations shall be connected into alarm-initiating circuits. Stations shall be installed on semi-flush mounted outlet boxes. Stations shall be single action type. Stations shall be addressable. Stations shall be finished in red, with raised letter operating instructions of contrasting color. Stations requiring the breaking of glass or plastic panels for operation are not acceptable. Stations employing glass rods are acceptable. The use of a key or wrench shall be required to reset the station. Gravity or mercury switches are not acceptable. Switches and contacts shall be rated for the voltage and current upon which they operate. Stations shall have a separate screw terminal for each conductor. Surface mounted boxes shall be painted the same color as the fire alarm manual stations. Addressable pull stations shall be capable of being field programmed, shall latch upon operation and remain latched until manually reset.

### 2.5 FIRE DETECTING DEVICES

Fire detecting devices shall comply with the applicable requirements of NFPA 72, NFPA 90A, UL 268, and UL 521. The detectors shall be provided as indicated. Detector base shall have screw terminals for making connections. No solder connections will be allowed. Detectors shall be connected into alarm initiating circuits. Detectors located in concealed locations (above ceiling, etc.) shall have a remote visible indicator lamp. Installed devices shall conform to the classification of the area. Addressable fire detecting devices except flame detectors shall be dynamically supervised and uniquely identified in the control panel.

#### 2.5.1 Heat Detectors

Heat detectors shall be designed for detection of fire by fixed temperature or combination fixed temperature and rate-of-rise principle as indicated. Heat detectors shall be rated for a minimum of 15.2 m spacing (smooth-ceiling rated) in accordance with UL 521. Detectors located in areas



subject to moisture, exterior atmospheric conditions or hazardous locations as defined by NFPA 70, shall be types approved for such locations. Heat detectors located in attic spaces or similar concealed spaces below the roof shall be intermediate temperature rated.

#### 2.5.1.1 Combination Fixed-Temperature and Rate-of-Rise Detectors

Detectors shall be designed for semi-flush outlet box mounting and supported independently of wiring connections. Contacts shall be self-resetting after response to rate-of-rise principle. Under fixed temperature actuation, the detector shall have a permanent external indication which is readily visible. Detector units located in boiler rooms, showers, or other areas subject to abnormal temperature changes shall operate on fixed temperature principle only. Rating for fixed temperature portion shall be 57.2 degrees C in temperature conditioned spaces.

#### 2.5.1.2 Fixed Temperature Detectors

Detectors shall be designed for semi-flush outlet box mounting and supported independently of wiring connections. Detectors are designed to detect high heat. The detectors shall have a specific temperature setting of 57.2 or 93.3 degrees C.

#### 2.5.1.3 Duct Detectors

Duct detectors are provided under Section 15950 Heating, Ventilation, and Air Conditioning HVAC Control Systems.

#### 2.5.2 Single Station Smoke Detectors

Single station smoke detectors shall have an audible device (self-contained) and be designed for detection of abnormal smoke densities by the photoelectric principle. Single station smoke detectors shall be rated for 24 volts DC and be powered by the Fire Alarm Control Panel. Smoke detectors shall be provided with an LED light source. Failure of the LED shall not cause an alarm condition and the sensitivity shall be factory set at a nominal 3 percent and require no field adjustments of any kind. The audible appliances shall have a minimum sound output of at least 85 dBA at 3.048 m. Detectors shall contain a visible indicator lamp that shows when the unit is in alarm condition. Detectors shall not be adversely affected by vibration or pressure. Detectors shall be nonlatching devices.

#### 2.6 NOTIFICATION APPLIANCES

Audible appliances shall be heavy duty and conform to the applicable requirements of UL 464. Devices shall be connected into alarm indicating circuits and shall have a separate screw terminal for each conductor. Devices shall be painted red similar to FED-STD 595 color, number 11105.

##### 2.6.1 Alarm Horns

Horns shall be surface mounted, with the matching mounting back recessed mounted, grill and vibrating type suitable for use in an electrically supervised circuit. Horns shall produce a minimum sound rating of at least 90 dBA at 3.048 m. Horns used in exterior locations shall be specifically listed or approved for outdoor use and be provided with metal housing and protective grills.

## 2.6.2 Visual Notification Appliances

Visual notification appliances shall have high intensity optic lens and flash tubes. Strobes shall flash at approximately 1 flash per second and a minimum of 15 candela. Strobe shall be semi-flush mounted.

## 2.6.3 Combination Audible/Visual Notification Appliances

Combination audible/visual notification appliances shall provide the same requirements as individual units except they shall mount as a unit in standard backboxes. All units shall be factory assembled. Any other audible indicating appliance employed in the fire alarm systems shall be approved by the authority having jurisdiction.

## 2.7 REMOTE ANNUNCIATION EQUIPMENT

### 2.7.1 Remote Graphic Annunciator

Graphic annunciator shall have a plan view of each floor of the building. Each initiating device shall be indicated by an LED lamp shown in its relative position in the building. One individual lamps shall be provided for each zone and shall illuminate for an alarm condition in that device. Lamps shall be red. Plan views shall be approximately to scale and in no case smaller than 375 mm in length or width. Annunciator shall have a door with piano hinge and two point cylinder lock or two cylinder locks. Lock shall be operable using the same key as the control panel. Annunciator shall contain a lamp test switch, audible trouble signal and a trouble switch to silence the audible alarm, but not extinguish the trouble lamp. Annunciator shall be semi-flush mounted.

## 2.8 FIRE DETECTION AND ALARM SYSTEM PERIPHERAL EQUIPMENT

### 2.8.1 Ground Rods

Ground rods shall be of copper clad steel conforming to UL 467 19.1 mm in diameter by 3.1 m in length.

### 2.8.2 Conduit

Conduit and fittings shall comply with UL 6, UL 1242 and UL 797.

### 2.8.3 Wiring

Wiring for 120V ac power shall be No. 12 AWG minimum. Wiring for low voltage dc circuits shall be No. 14 AWG minimum. Power wiring (over 28 volts) and control wiring shall be isolated. All wiring shall conform to NFPA 70. System field wiring shall be solid copper and installed in metallic conduit or electrical metallic tubing, except rigid plastic conduit may be used under slab-on-grade. All conductors shall be color coded. Conductors used for the same functions shall be similarly color coded. Wiring code color shall remain uniform throughout the circuit. Pigtail or T-tap connections to alarm initiating, supervisory circuits, and alarm indicating circuits are prohibited. T-tapping using screw terminal blocks is allowed for addressable systems.

#### 2.8.4 Special Tools and Spare Parts

Special tools necessary for the maintenance of the equipment shall be furnished. Two spare fuses of each type and size required and five spare lamps and LED's of each type shall be furnished. Two percent of the total number of each different type of detector, but no less than two each, shall be furnished. Fuses and lamps shall be mounted in the fire alarm panel.

#### 2.8.5 Transmitter

Fire alarm transmitters shall be compatible with a Monaco CAM-6 system.

### 3 EXECUTION

#### 3.1 INSTALLATION

All work shall be installed as shown and in accordance with the manufacturer's diagrams and recommendations, unless otherwise specified. Smoke detectors shall not be installed until the building has been thoroughly cleaned.

##### 3.1.1 Power Supply for the System

A single dedicated circuit connection for supplying power to each building fire alarm system shall be provided. The primary power shall be supplied as shown on the drawings. The power supply shall be equipped with a locking mechanism and marked "FIRE ALARM CIRCUIT CONTROL" with a rigid plastic nameplate.

##### 3.1.2 Wiring

Wiring for systems shall be installed in 19.1 mm minimum diameter conduit. Wiring for the fire alarm system shall not be installed in conduits, junction boxes, or outlet boxes with conductors of lighting and power systems. No more than one conductor shall be installed under any screw terminal. All circuit conductors entering or leaving any mounting box, outlet box enclosure or cabinet shall be connected to screw terminals with each terminal marked in accordance with the wiring diagram. Connections and splices shall be made using screw terminal blocks. The use of wire nut type connectors are prohibited in the system. Wiring within any control equipment shall be readily accessible without removing any component parts. The fire alarm equipment manufacturer's representative shall be present for the connection of wiring to the control panel.

##### 3.1.3 Control Panel

The control panel and its assorted components shall be mounted so that no part of the enclosing cabinet is less than 300 mm nor more than 2 m above the finished floor. All manually operable controls shall be between 900 mm to 1.1 m above the finished floor. Panel shall be installed to comply with the requirements of UL 864.

##### 3.1.4 Detectors

Detectors shall be installed in accordance with NFPA 72. Detectors shall be at least 300 mm from any part of any lighting fixture. Detectors shall be located at least 900 mm from diffusers of air handling systems. Each

detector shall be provided with appropriate mounting hardware as required by its mounting location. Detectors which mount in free space shall be mounted directly to the end of the stubbed down rigid conduit drop. Conduit drops shall be firmly secured to minimize detector sway. Where length of conduit drop from ceiling or wall surface exceeds 900 mm, sway bracing shall be provided.

#### 3.1.5 Notification Appliances

Notification appliances shall be mounted a minimum of 2.4 m above the finished floor unless limited by ceiling height or otherwise indicated.

#### 3.1.6 Annunciator Equipment

Annunciator equipment provided shall be mounted where indicated.

### 3.2 OVERVOLTAGE AND SURGE PROTECTION

All equipment connected to alternating current circuits shall be protected from surges per IEEE C62.41 and NFPA 70. All cables and conductors which serve as communications links, except fiber optics, shall have surge protection circuits installed at each end. Fuses shall not be used for surge protection.

### 3.3 GROUNDING

Grounding shall be provided to building ground or ground rods shall be driven. Maximum impedance to ground shall be 25 ohms. Ground rods shall not protrude more than 150 mm above grade.

### 3.4 TESTING

The Contractor shall notify the Contracting Officer 30 days before the preliminary and acceptance tests are to be conducted. The tests shall be performed in accordance with the approved test procedures in the presence of the Contracting Officer. The control panel manufacturer's representative shall be present to supervise all tests. The Contractor shall furnish all instruments and personnel required for the tests.

#### 3.4.1 Preliminary Tests

Upon completion of the installation, the system shall be subjected to functional and operational performance tests including tests of each installed initiating and notification appliance. Tests shall include the meggering of all system conductors to determine that the system is free from grounded, shorted, or open circuits. The megger test shall be conducted prior to the installation of fire alarm equipment. If deficiencies are found, corrections shall be made and the system shall be retested to assure that it is functional.

#### 3.4.2 Acceptance Test

Testing shall be in accordance with NFPA 72H. The recommended tests in NFPA 72H shall be considered mandatory and shall verify that all previous deficiencies have been corrected. The test shall include the following:

- a. Test of each function of the control panel.

- b. Test of each circuit in both trouble and normal modes.
- c. Tests of alarm initiating devices in both normal and trouble conditions.
- d. Tests of each control circuit and device.
- e. Tests of each alarm notification appliance.
- f. Tests of the battery charger and batteries.
- g. Complete operational tests under emergency power supply.
- h. Visual inspection of all wiring connections.
- i. Opening the circuit at each alarm initiating device and notification appliance to test the wiring supervisory feature.
- j. Ground fault
- k. Short circuit faults
- l. Stray voltage
- m. Loop resistance

### 3.5 TRAINING

Training course shall be provided for the operations and maintenance staff. The course shall be conducted in the building where the system is installed or as designated by the Contracting Officer. The training period shall consist of 3 training days (8 hours per day) and shall start after the system is functionally completed but prior to final acceptance tests. The instructions shall cover all of the items contained in the operating and maintenance instructions.